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BY

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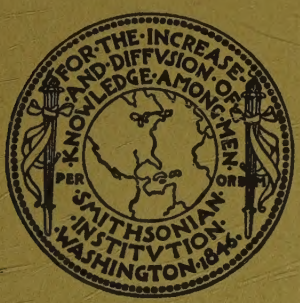


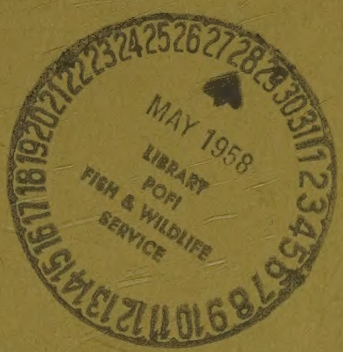


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# NORTH AMERICAN COPEPODS OF THE FAMILY NOTODELPHYIDAE

By Paul L. Illg [1]

## Introduction

The notodelphyid copepods are almost universally inhabitants of the body cavities of ascidians. Correlated with this specialized mode of existence is the elaborate series of structural modifications displayed by these organisms. Preservation of fundamental characteristics, in spite of a high degree of adaptive radiation, renders the group a well-defined natural unit. The members of this family are poorly known, however, over the greatest extent of their occurrence and information concerning North American representatives is particularly meager. Despite their interesting biological features, these ascidicoles have been neglected by the taxonomist and ecologist alike.

To the specialist on copepods the principal limitation on availability of notodelphyids is the obvious fact that their occurrence is dependent upon that of the host organisms. The methods of obtaining and working over ascidians do not form a usual part of the operations of workers on the copepods. Considering the significant biological implications of the ascidicoles, they have received little notice from the specialists on ascidians. It is rare to chance upon a note in the

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literature on ascidians that even mentions these almost constantly present associates.

The record of these organisms, from the standpoint of world distribution, is equally scanty. The only outstanding faunistic records are provided by the excellent knowledge available of occurrence of ascidicoles on the coasts of the Scandinavian countries and on the Mediterranean shores of Europe.

As a result of the lack of distributional knowledge and ignorance of the majority of extant forms, the systematics of this group is in a very undeveloped state. The scattered references to the group have never been brought together on a large scale. The neglect of the ascidicoles is undoubtedly at least partially due to the fact that both they and their hosts have distinctly minor practical or economic importance. The worker on the copepods thus is confronted first with the problem of obtaining host material, and then with the even greater difficulty of obtaining valid determinations of the host species.

No large-scale work has been published on the North American notodelphyids. The records available from this area, including Greenland, are from the reports of Blake (1933), Gray (1938), Hansen (1923), Henderson (1931), Herdman (1898), Huntsman (1912), Pearse (1947, 1952), Stephensen (1913), and Wilson (1920, 1932, 1935a, 1935b).

The present material has been available from the most diverse situations in North America. Although the primary aim has been the establishment of the North American representation of the family Notodelphyidae, a thorough study along these lines has required careful perusal of the records of world distribution. Since this is the first time a compilation of such extent has been available, the opportunity is taken of presenting a bibliography of the notodelphyids and synonymies of the species. References compiled in the bibliography are all those which were thought significantly to affect taxonomic evaluation or provide definite information as to distribution. Incidental references to various of the genera or species are scattered throughout the whole of the literature on copepods and complete coverage of such items was not attempted. In the listing of hosts, all the different names used by authors are presented, although it is presumed some are synonymous. Further, these are quoted as found in the literature, with such attribution of authority as provided in the reference concerned only. The task of bringing the usages involved and the identifications of hosts into accordance with the modern classification of ascidians must devolve upon a specialist in that field. There is still the need for similar treatment of the remaining families of ascidicolous copepods. It is hoped that the present attempt will

demonstrate that the project is a rewarding one in terms of the array of biological information disclosed.

In the genera not actually studied in the present work the taxonomy of the earlier workers is accepted and the scheme of G. Sars (1921) is used, supplemented, where it is incomplete, from Schellenberg (1922). However, the necessity of proposing new genera to recognize the new information concerning the anatomy of the group brought forth from the study has led to the formation of six new combinations as nomenclatural concepts. Most of the reallocations of species have involved those originally proposed in the genus *Doropygus*, which, by combining the work of Sars in 1921 and the present study, has been finally subdivided into four genera. The present study has produced records in 11 genera of 23 species, of which 14 are described as new to science.

New findings of zoogeographic interest include the rediscovery of a typical arctic species, unreported since its original description, now found in collections ranging from Point Barrow, Alaska, to the Gulf of Maine, and to the north coast of Siberia. Still another instance is the establishment of the occurrence of a long-known Mediterranean species in considerable numbers along the Gulf Coast of Florida. A large number of species seems to be entirely restricted to North America, but such findings as the above leave reason to assume that some of these species will be found to have wide distributions. The almost cosmopolitan species, *Doropygus pulex* Thorell, has been found only on the east coast of North America. Only six typically European species have so far been found in the American fauna.

## Acknowledgments

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## Methods

The problems of collection of notodelphyids is in the main that of obtaining quantities of ascidians, the host organisms. Ascidians are entirely marine, very few tolerating even an approach to brackish conditions. Availability of free-flowing currents of water is a prime requisite for abundance of ascidians, which are notable and conspicuous members in the aggregations of animals encrusting piers and floats. However, personal experience in the accumulation of the present series indicates that the most favorable site for obtaining infested ascidians would be bottom-dwelling beds, usually those well below the level of tidal fluctuation. Dredging is therefore the recommended procedure for collecting the hosts.

Relatively few notodelphyids inhabit compound ascidians. The few that so occur are most readily obtained by observation of the living host. There ususally is a high degree of transparency, or at least translucence, of the compound tunicate, which favors detection of the dissimilar texture, and often color, of the infesting copepod, particularly under illumination for microscopic examination. Teasing out of zooids is necessary for the capture of the forms inhabiting the branchial cavities. Teasing of the matrix or systematic slicing of the colony may produce favorable results in the search for the species that live in the common channels or lie independently in matrical cavities.

The majority of forms live within the bodies of simple, or solitary, ascidians. These may be tumbled out by wholesale slicing of quantities of ascidians. It is preferable, however, to obtain the ascidicoles by dissection of the host, which procedure assures the preservation of an ascidian specimen for taxonomic identification and yields the optimum in details of biological relationships of host and commensal or parasite.

For dissection it is necessary to orient the ascidian. If the siphons are obvious, the tunic may be slit well away from them and peeled like a rind from the enclosed body. If there is no surface landmark for orientation, the best procedure is cautious peeling to expose the body and establish the location of the siphons. The specimen then should be sectioned just to one side of the median plane, preferably by a cut of deeply inserted scissors. The median plane is established as the line passing through the siphons and the cut is arranged to

start at one siphon and end at the other, leaving the resultant halves united by the intersiphonal portion of the body. In individuals with thin tests this procedure can be accomplished by cutting directly through test and all. The body, after sectioning, may be spread open and pinned down, preferably under fluid. Exposed to view will be the inner wall of the pharynx with the mid-dorsal line running down the center. A number of commensals live in the pharynx and may be observed with the naked eye or relatively low powers of magnification. The plications of the pharynx of species of ascidians thus complicated in structure should be lifted and all the recesses exposed. To expedite search in the atrium, or peribranchial cavity, the pharynx should be separated from the mantle, preferably under a dissecting microscope, by lifting it at the edges and severing the many small vascular strands that connect it to the mantle lying below. Since the number and arrangement of the principal vessels making up the pharynx wall are of systematic importance, care should be taken to prevent damage to them. The gut and gonads will be among the organs exposed in the atrial cavity. Damage to these should likewise be avoided. The wall of the stomach should be slit and the cavity investigated as a further likely harbor for copepods.

Preservation of the ascidicolous copepods is equally well achieved in formalin or alcohol. Sometimes the standard fixatives, such as Bouin's or Gilson's fluids, yield particularly well-preserved specimens. Many species can be narcotized to a state of relaxation that favors fixation by prior immersion in a small quantity of sea water upon the surface of which are floated a few drops of oil of cloves. Satisfactory results are obtained by bulk preservation of ascidians as they are collected, in standard strengths of alcohol or formalin, with subsequent exploration for the ascidicoles. Museum specimens of ascidians nearly one hundred years old have yielded copepods suitable for taxonomic identification.

For systematic determination it was found necessary to prepare microscopic dissections of the copepods. The specimens were all brought into alcohol for permanent storage. Staining was accomplished in 95 percent alcohol, first tinged distinctly yellowish with picric acid, then colored deep transparent green by the addition of a few drops of Fast Green, saturated solution in 95 percent alcohol. Staining was progressive and carried on until the setae and similar elements of ornamentation were distinctly but lightly colored. The specimens were rapidly passed through a rinse to Euparal, in which medium they were dissected with finely pointed small needles. Appendages were serially removed and each pair independently mounted under a 9×9 mm. coverslip on one 1×3 inch slide, so that the whole individual was represented on the finished single mount.

## Modes of existence

The notodelphyids are most frequently restricted to the branchial cavities of the tunicates they inhabit. The members of this group show the least modification of appendages, and probably implications with regard to feeding habits might be drawn. Very evidently the food supply of the tunicate is directly shared, although there is no actual record available of the food of the notodelphyids. Representatives with most degenerated appendages come from more specialized habitats. One genus has been taken from the common cloaca of the systems of zooids of a compound ascidian. The mouthparts are so reduced in this genus that it is doubtful if the animal could ingest particulate matter. Other genera occupy such specialized sites as cyst-like cavities in the matrix of compound tunicates, cysts under the tunic of solitary ascidians, or with only the head encysted in the mesenchymal tissue of the host. The ultimate location in this line of parasitic adaptation is in cysts enveloped within the ventral blood vessel of representatives of two genera of solitary tunicates. The question of the mode of penetration of these specialized symbionts to their sites within the hosts is still unanswered. In fact, the sequence of developmental events and possible metamorphoses in the life histories of these ascidicoles is almost entirely unknown. It is obvious that much of the development in most species takes place away from association with the definitive hosts. In *Notodelphys* species several subadult stadia are passed in the body of the tunicate but this does not seem to be the case in most other genera. In many genera the males have not been found and it seems plausible to assume that they are preponderantly free-swimming. However, an additional factor must be considered before applying this conclusion. The collection and examination of the host, and the resulting unnatural and untoward conditions, may well bring about the departure of some of the associated copepods. Stock (1951) reports that slight staleness of the water in which tunicates are kept may stimulate even heavily ovigerous females of *Notodelphys* to swim forth. It may then be that males and young of most species are simply too nimble to be taken by usual means of capture in their accustomed habitat.

Of further biological interest in the existence of ascidicolous copepods is their relationship with other symbiotic organisms of the host tunicates. Della Valle has described how *Doroixys* has been taken in the branchial cavity of the zooid of a compound ascidian in which the posterior body mass of the same zooid housed an enterocolid copepod. Four or more genera of notodelphyids may actually be

represented in the symbiont assemblage in the body of a single individual solitary tunicate. In addition to notodelphyids, other copepod groups may be represented. All of the ascidicolids, buprorids, enterocolids, enteropsids, and botryllophilids are also ascidicoles. Some species of the genus *Lichomolgus* are restricted in habitat to certain tunicates. Specimens of a variety of asterocherids and of harpacticoids may occur as occasional or accidental guests of ascidians.

A notable subordinate association, frequently encountered, is the epizootic attachment of ciliate protozoans on notodelphyids. The setae of the appendages seem especially favored sites of attachment and one may often find the details of anatomy obscured by the burden of attached protozoans.

Amphipods are as commonly symbiotic with tunicates as are the ascidicolous copepods. Somewhat less commonly encountered inside tunicates, but with an actually high degree of symbiotic occurrence, are sporozoan protozoans, hydroids, flatworms, nemerteans, nematodes, polychaetes, and pinnotherid crabs. In a representative lot of tunicates assembled for the present study, a series of 20 specimens of one species was taken in a single dredge haul. Three hundred odd specimens of a species of *Doropygus* were removed from the branchial cavities. Twenty-eight amphipods (*Leucothoe* sp.) were obtained, the great majority in the atrial chambers. There were five specimens of a polychaete, both from atria and branchial baskets; and two male pinnotherids from branchial cavities completed the roster of more obvious associated animals.

The complexity of interrelationships among the ascidicolous organisms forms a most challenging ecological problem. There is virtually no record in the literature on this subject, and the possibilities from both the strictly observational and the experimental standpoints must be manifold. As a preliminary offering, here is recorded the first instance of direct impact of one of the symbiont categories upon another, for the detection of which I am indebted to Dr. Cadet Hand. A specimen of a solitary tunicate collected in Washington Sound, Washington, was found to house a number of notodelphyid copepods and a thriving colony of a hydroid, *Entocrypta huntsmani*. In one of the polyps of the hydroid was found the completely ingested body of an ovigerous female notodelphyid of very considerable bulk. Others of the same species were still thriving in the branchial chamber. What the regular food of the hydroid is no one so far has recorded, but the possibilities of complex cycles of nutritive relationships form one of the more obvious ecological corollaries of the biotic complex of ascidicolous organisms.

## Family Notodelphyidae

Type genus: *Notodelphys* Allman, 1847a.

Description and morphological considerations: The family Notodelphyidae, as here considered, is defined by application of two major restrictive criteria: the development of a brood sack enclosed within the body and the occurrence of a prehensilely modified articulated hook as the terminal member of the antenna. The establishment of the homologies involved in the parasitic degradation of the various appendages in the most highly modified representatives is impossible from the meager information available. Generalities as to features of the appendages are here presented as a bare summary since species treated in extended descriptions in the succeeding part of this paper cover the full range of occurrence within the family.

The rostrum is a constant feature among the diverse array of notodelphyids. In its basic form it is an inflated cone, with little or no tendency to ornamentation.

The antennule varies from the generalized, many-segmented type like that of the most primitive cyclopoids to the bimerous or monomerous stumps of the parasites. The antenna is uniramous, a basically trimerous appendage, with relatively sparse ornamentation. The terminal armature is invariably a stout clawed articulated hook.

The development of a labrum is an almost unexceptional feature of the group. Sufficiently representative occurrences are known of the presence of paragnaths to conclude that these structures, also, are fundamentally present in notodelphyids.

Great conformity of the mouthparts is found throughout the group, except that in the parasitically degenerated extremes the homologies of these appendages are obscured. The typical mandible consists of a medially expanded basal segment and a variously ornamented palp. The maxillule consists of a masticatory basal portion with a biramous palp. The maxilla is basically pentamerous and uniramous. A very distinctive armature of medially inserted setae constitutes its principal functional component. The maxilliped is reduced, varying from trimerous to monomerous, with relatively few elements of armature differentiated.

The four pairs of swimming legs are variations upon a fundamentally cyclopoid type, bearing out the probable derivation of the group from such a free-swimming assemblage. The basic pattern consists of bimerous protopodites yoked together by an intercoxal lamella and bearing trimerous rami, the exopodite, and the endopodite. The armature consists of variously differentiated setae and spines. In the advanced parasites, the legs may be reduced to unornamented stumps.

The fifth legs are vestigial, as is typical of all the cyclopoids. The

appendage is basically a uniramous, bimerous one. The ornamentation consists at most of one to few weakly developed setae or spines. In many lines of descent within the group the fifth legs are obsolete to lacking.

Reference to the body regions of a notodelphyid as head, thorax, and abdomen is useful but throughout necessitates careful qualification. The tagmosis of the copepods presents a thorny problem and much discussion of it has appeared in print. There is a major dichotomy in the group as to the arrangement of the principal body regions. Realization of this fact plus an attempt to reconcile copepod structure with that of other major crustacean and arthropod groups has produced great ambiguity in terms of reference, and the number of schools of thought on the arrangement of the copepod body almost approaches the number of authorities who have expressed themselves. The basic disposition of the somites in copepods forms two major body regions with one additional, readily determined subdivision. There is an articulation between an anterior major mass, bearing the head structures and swimming legs, and a posterior sector with appendages insignificant to lacking. The alternatives of arrangement of this articulation delimit two principal sections of the copepods, the Gymnoplea, in which no limbs are borne on the posterior sector, and the Podoplea, which have a posterior sector bearing a pair or two of rudimentary limbs. The posterior sector, the importance of which is thus readily apparent, has been called abdomen, urosome, hind-body, and similar names, preference being shown to noncommittal expressions. The reasons for any equivocation are good ones. First, the articulation is one which does not have an exact counterpart in other major crustacean groups.

Second, the hind-body in the copepods undoubtedly has two major anatomical components. In the podopleans the first two somites are pedigerous. The second of these, further, is characterized by possession of the reproductive apertures. The conformity of these somites to the posterior thoracic segments of the majority of crustaceans is apparent. In the gymnopleans the body articulation occurs one segment posterior to the position found in podopleans. The first segment of the gymnoplean hind-body, although not pedigerous, includes the genital apertures. A thoracic series plus an abdominal series of somites thus would be seen to characterize the copepod hind-body. In females throughout the Copepoda a further complication occurs. The segment of the genital orifices usually fuses with the succeeding somite to form a compound metamere, usually exhibiting some expansion and often other elaboration. The participant elements in this complex then would seem to be one anatomically thoracic somite and one anatomically abdominal somite. As we shall

see below, however, the formation of this compound somite is not a characteristic feature throughout the notodelphyids.

In addition to the subdivision of the copepod body provided by the principal articulation, the tagmosis is further modified by the fusion of anterior segments into a cephalothoracic region, leaving several free thoracic segments anterior to the body hinge.

Finally, in *Botachus*, *Pachypygus*, and *Notopterophorus* especially, the insertion of the caudal rami is upon a complicated structure which tends to become ensheathed by the preceding abdominal segment. This reduced structure seems to be a perianal ring, and has been designated, since Giesbrecht, as the terminal abdominal segment. (In usual anatomic reference among crustacea, the perianal ring is not considered to be a true somite.)

The fundamental plan of segmentation of the body in the Notodelphyidae is exhibited in the male of *Notodelphys* spp. The major body articulation is podoplean in character. The main mass of the trunk is cephalothoracic-thoracic and it bears most of the appendages, through the fourth swimming legs. This metasomal assembly is basically 5-segmented, with the segments diverse. Nearly half the metasomal mass is the fused cephalothoracic element which supports all the head appendages and the maxillipeds. The succeeding four much-less-extensive segments each support the appropriate pair of thoracic swimming legs. The urosome, posterior to the major hinge of the body, comprises two thoracic segments and four abdominal segments (to include the telson, or perianal segment). The first urosomal segment is the fifth free thoracic segment, or the sixth limb-bearing segment attributable to the thoracic series. It supports the relatively well-developed fifth legs. The second urosomal segment, attributed by convention to the thorax, is characterized by possession of the paired reproductive apertures. These, and the segment itself, are complicated in structure by the presence of elaborate anatomical features connected with the formation of the characteristic spermatophoral capsules. The posterior ventral margin of this segment is produced into paired prominences which support two to three setae. These protrusions throughout the cyclopoid series have been long accepted as the vestiges of sixth legs (or seventh thoracic appendages).

In the males of some other genera there is also a complication of urosomal segmentation involved. This seems to be related to an extension of the structures related to the spermatophores to occupy both the thoracic somites of the urosome. The result is a more or less complete fusion of the sixth and seventh thoracic somites, with the spermatophoral capsules extending the length of the resultant segment. The sixth legs, as is usual, are prolongations of the posterior ventral margin of the structure. The fifth legs lie in rather close

apposition to the ventral surface, usually at a level about midway on the longitudinal extent. There may or may not be an obvious line of articulation in the integument of the segment at the level of the fifth legs (e. g., species of *Doropygus*, *Doropygopsis*, and *Doropygella*).

In the males of species of *Notodelphys* the segment of the fifth legs is a well-developed, freely articulated one but is intruded considerably by the spermatophoral capsules.

The majority of notodelphyid males (where they are known) conform to the above generalized plan of metasomal tagmosis. The females of the genera in which parasitic degeneration does not obscure the basic features of segmentation, in the main conform to this plan, but there are notable exceptions. The females of *Notodelphys* and, most strikingly, *Lonchidiopsis* are organized in a pattern seemingly conforming to the gymnoplean arrangement of the calanoid copepods. In *Lonchidiopsis*, an extremely aberrant notodelphyid, the bulk of the body is an expanded segment which, besides accommodating the incubatorium, supports the fourth and fifth legs; the urosome has no thoracic appendages. This tendency is also clearly seen in *Notodelphys*.

In *Notodelphys monoseta*, the last metasomal segment is the expanded incubatory complex. At its anterior articulation are borne the fourth legs; the fifth legs are set at the posterior edge and protrude posteriorly just to reach the anterior margin of the first urosomal somite. In specimens of *N. allmani* from Oban, Scotland, I find the fifth legs borne on the ventral surface of the incubatory segment, and they lie very far removed anteriorly from the hind margin of this segment.

Still further complicating the issue is the fact that the organization of the metasome in *Botachus* is very similar to that in *Notodelphys*, as was clearly shown by Kerschner in 1879. The closest affinities of *Botachus* are not readily evident but would seem to be somewhat closer to the *Pachypygus-Notopterophorus* group of forms than to *Notodelphys*. But the body is a depressed one and this very likely is the critical factor in the tagmosis. The mechanics of the articulation of the hind-body are obviously profoundly affected by the compact, depressed mass which the metasome forms.

In *Notodelphys* females there are five urosomal segments, including the so-called "segment" supporting the caudal rami; none are pedigerous. The four posterior-most are abdominal. The first, which bears the oviducal apertures, is accordingly here considered to be the seventh "thoracic" somite; it affords a most exceptional instance among copepods of this thoracic segment being free of the usual fusion with the first abdominal somite. In the species of *Doropygus* I have examined this condition also seems to exist, so that the urosome here

actually has six segments including that of the fifth legs. Other genera allied to *Doropygus* in the feature of having podoplean segmentation return to the 5-segmented urosome by accomplishing the fusion of last thoracic and first abdominal somites. This is true of *Doropygopsis* as a salient example.

The urosomal segmentation in *Notodelphys* then corresponds to the most generalized structure in the Calanoida (Gymnoplea). That in the males is of the most generalized podoplean or cyclopoid type. The mechanics of the major body articulation are complicated by the combination of effects produced by inflation of the body, with, in addition, either compression or depression markedly developed. As a result, the tagmosis in representatives of the family presents a graduated series of arrangements that spans the major subdivision in this feature, which has held as a differentiating characteristic in dichotomous arrangement of the copepods. There are both "podoplean" and "gymnoplean" notodelphyoids.

Although he did not describe the situation aptly, G. Sars (1921) was aware of a major difference in tagmosis of the female notodelphyids. He accordingly restricted the family Notodelphyidae to include *Notodelphys* (and *Agnathaner*) with "tail composed in both sexes of five segments not very different in size." He further accepted the family Doropygidae, as proposed by Brady (1878), to include 10 genera more or less closely resembling *Doropygus*, and defined, in part, by Sars as with "tail cylindrical in shape, and in most cases only composed of four distinctly defined segments." Thus, upon closer analysis, we have seen that the actual facts of the tagmosis are almost contrary to what Sars considered them.

Undue emphasis doubtless has also been placed upon the possible significance of compression and depression as major diagnostic characters in notodelphyids. A newly found species among the present material is compressed in habitus, although in all details of anatomy of the appendages it conforms to a genus in which all previously known representatives are depressed. Schellenberg (1922) was led to include in the genus *Doropygus* by their compressed habitus three species which are clearly much more closely allied to *Notodelphys* when the features of their appendages are taken into account.

As to the alternative possibilities of fusion of the segment of the first swimming legs with the head or persistence as a separate unit, as will be shown below, the records have not been consistently reliable in the past. Further, both conditions seemingly may occur in a single genus. Accordingly the bearing of this question on the higher levels of classification, in the present state of knowledge, is not clear.

The various trends of modification in the degenerated parasitic lineages within the group have further significance in the problem of

the tagmosis of the notodelphyids. A major tendency, quite obviously independently initiated in more than one of the related assemblages within the group, is the encroachment of the brood sack upon successively more of the thoracic somites until all those bearing swimming legs come to be incorporated in the incubatory structure. A second important trait is the coalescence of segments as parasitic modification advances.

The internal anatomy of the notodelphyids for the most part remains to be described. In keeping with many copepods, the members of this family lack respiratory and circulatory structures. There is no full description of the musculature of any representative available. Features of the excretory organs and of the digestive and nervous systems are known only as isolated details scattered through the references to the group.

The reproductive system was extensively studied in *Notopterophorus* by Giesbrecht (1882a), and Canu (1892) added many details from his studies on a number of forms. The typical female reproductive system of notodelphyids conforms to the general pattern found among copepods. There is a single medial ovarian mass located dorsally in the metasome. Paired oviducts traverse the body from the level of the ovary to the seventh thoracic segment, which is invariably located on the urosome as the first or second segment. The oviducts open dorsolaterally as rather elaborately developed genital atria, these frequently being shielded at the orifices by modified tegumentary structures. A seminal apparatus is also a feature of this genital somite. There is a median pore on the ventral surface, which serves as a site of attachment for the spermatophores transferred from the male in copulation. From the pore a short canal proceeds laterally on either side to the paired seminal receptacles which lie in close relation to the genital atria. From the seminal receptacles the sperm passes to the eggs in the genital atrium as they are being extruded into the brood sack. The arrangement of paired seminal reservoirs has been suggested as a possible diagnostic character of the family Notodelphyidae. It is certainly in contrast to the condition found in the genus *Cyclops* in which typically a large single median seminal receptacle is developed. However, the discernment of this anatomical feature is difficult and the condition in the majority of the Cyclopinidae, for which information would be most significant, has not so far been recorded.

The male reproductive system is less well known than the female. Canu (1892, pls. 6, 8) provided detailed illustration of this tract in two genera, and these features conform well to the generalized cyclopoid condition.

A large single testis occupies the dorsal median portion of the first three thoracic segments. It may protrude anteriorly into the hinder portion of head. A deferent duct takes its origin rather far forward on the testicular mass on either side. The duct first is arranged as a highly convoluted section, which lies opposite the anterior third of the testis, then courses directly posteriorly to the seventh thoracic somite, which is the genital segment, located in the urosome. Most of the duct seems to be highly glandular, and considerable enlargement is developed posterior to the convoluted portion. Each duct terminates in a large seminal vesicle, in which the spermatophoral capsule is elaborated. The seminal vesicles occupy most of the ventral portion of the genital segment. Each may intrude considerably into the next anterior segment of the fifth legs. The large apertures of the seminal vesicles are overlain by the protective integumentary flaps, usually bearing two setae, which are considered to be the sixth legs. The spermatophores are somehow removed from these orifices and cemented to the midventral seminal aperture of the female in the act of copulation.

Canu (1892) made an outstanding contribution in the description of developmental stadia for five species encountered by him. Unfortunately his treatment of the later stages was not recorded in terms of the criteria of modern usage and these remain to be reappraised. No subsequent life history study adding greatly to this basic information has been found in the literature search made for the present paper.

K. Lang (1949) described a new family of copepods, the Archinotodelphyidae, to include some very primitively constructed ascidicolous copepods. These would, basically, require only the anatomical modifications of provision of an internal brood sack and some slight alterations in some of the appendages to apply to a familial definition which would accommodate the series of genera herein assigned to the Notodelphyidae. They thus possess points of structure which strongly indicate that they may be a remnant of the archetypical stock which gave rise to the notodelphyids. Further, the inclusion of the archinotodelphyids within the family Cyclopinidae, a long-known group of free-living cyclopoids, would be consequent upon fairly simple transformations of a few appendages.

This demonstration of the cyclopinid-notodelphyid phylogenetic series has led to the abandonment of the traditional usage, introduced by G. Sars (1921), which considers the majority of ascidicolous copepods as a suborder, the Notodelphyoida. The Notodelphyidae, Lang shows, are directly assignable to the cyclopinid stock within the Cyclopoida. Other ascidicolous families also show cyclopinid affinities, but not so obviously. One family among them Lang has considered to have affinity with a somewhat more remotely related cyclo-

poid series, the poecilostomes, so that the suborder of former usage is held by him to have been polyphyletic.

The classification of the notodelphyid ascidicoles then has resolved as a problem in practicality. There are good grounds for joining together the families Cyclopinidae, Archinotodelphyidae, and Notodelphyidae, since the distinctions between each two adjacent families are so minor, as pointed out above. If this combination were adopted, the problem of naming the assemblage would present difficulties. The name Notodelphyidae was used so early as a familial concept that it ought to deserve a weighty claim on grounds of mere priority. However, the disadvantage of applying the name is that the very phylogenetic trend which conveys biological significance to the grouping is thereby obscured. To preserve the phylogenetic considerations it would further be advisable to retain the separate categories at subfamilial level. This outcome, it seems obvious, offers so little gain over the treatment of the groups as separate families, that this latter alternative is here accepted.

A further consideration in the arrangement of the genera concerned is the proposition by Chatton and Brément (1915b) of a family Ophioseididae to include *Ophioseides*, *Brementia*, *Ooneides*. A grouping of the notodelphyoid genera which exhibit loss of one or more mouthparts would extend this series to include also *Scolecodes*, *Scolecimorpha*, *Pholeterides*, and *Dysgenopsyllus*. All of these exhibit extreme modifications toward parasitic degeneration. However, the great reduction of the appendages makes it impossible to determine whether the same mouthpart has been lost in each. This issue is the crux of the problem of establishing the series as monophyletic, and, thereby, its validity as a taxonomic unit. Accordingly, it is here considered that the most practical treatment could not recognize the ophioseidids as a family.

The existence of the ophioseidid genera in the notodelphyid series possessing incubatoria offers a possible objection to Lang's consideration of the enterocolids as poecilostomes. By the loss of mouthparts, the ophioseidids might be considered to qualify as poecilostomes, but the derivation of these genera seems so obviously demonstrable from the notodelphyid stock that other assignment would be purely arbitrary. Since the outstanding character of the poecilostomes is this more or less negative feature and the existence of a convergent parallel is available, the question arises whether the poecilostomes are not in fact an artificial, polyphyletic grouping. There are grounds in the definitions of some of the families to offer support to this suspicion. It seems entirely possible that further discoveries among the ascidicolous copepods may yet provide the links that can connect the enterocolids to the parental gnathostome stock. The question, it would seem, should remain an open one until further facts are available.

## Key to genera of *Notodelphyidae*, based upon females [2]

1*a*. All mouthparts represented . . . . . 2
1*b*. One or more pairs of mouthparts absent . . . . . 21

2*a*. Second to fourth exopodites reduced, segmentation obsolete . . . . . 3
2*b*. Second to fourth exopodites distinctly segmented . . . . . 4

3*a*. Fifth legs absent . . . . . **Prophioseides** (p. 480)
3*b*. Fifth legs present as reduced scales . . . . . **Campopera** (p. 480)

4*a*. Brood sack involves second to fourth thoracic segments . . . . . 5
4*b*. Brood sack involves principally fourth thoracic segment . . . . . 6

5*a*. Fifth legs absent . . . . . **Gnenotophorus** (p. 621)
5*b*. Fifth legs present . . . . . **Bonnierilla** (p. 480)

6*a*. Maxilliped consists of 3 setiferous segments . . . . . 7
6*b*. Maxilliped monomerous to trimerous, at most two segments setiferous . 10

7*a*. Body depressed . . . . . **Notodelphys** (p. 488)
7*b*. Body compressed . . . . . 8

8*a*. Endopodites 2 to 4 bimerous . . . . . **Notopterophorus** (p. 481)
8*b*. Endopodites 2 to 4 trimerous . . . . . 9

9*a*. Antennule 9- or 10-segmented . . . . . **Doropygopsis** (p. 591)
9*b*. Antennule of less than 9 segments . . . . . **Pachypygus** (p. 608)

10*a*. Armature of caudal rami variously developed setae . . . . . 11
10*b*. Armature of caudal rami variously developed clawlike spines . . . . . 18

11*a*. Basal segment of antenna with one or more well-developed plumose setae . . . . . 12
11*b*. Setation of basal segment of antenna much reduced or absent . . . . . 14

12*a*. Urosome 4-segmented . . . . . **Notodelphyopsis** (p. 511)
12*b*. Urosome 5-segmented . . . . . 13

13*a*. Maxilliped trimerous, or bimerous with three terminal setae. **Paranotodelphys** (p. 484)
13*b*. Maxilliped bimerous with two terminal setae . . . . **Pygodelphys** (p. 598)

14*a*. Fifth leg reduced to an unarticulated scalelike structure . . . . . 15
14*b*. Fifth leg articulated, well-developed . . . . . 16

15*a*. Fifth leg rudiment setiferous . . . . . **Doroixys** (p. 484)
15*b*. Fifth leg rudiment unornamented . . . . . **Pomphopygus** (p. 616)

16*a*. Body depressed . . . . . **Lonchidiopsis** (p. 485)
16*b*. Body compressed . . . . . 17

17*a*. Endopodite of maxillule with 6 or more setae . . . . **Doropygella** (p. 590)
17*b*. Endopodite of maxillule with less than 6 setae . . . . **Doropygus** (p. 518)

18*a*. Body depressed . . . . . **Botachus** (p. 485)
18*b*. Body compressed . . . . . 19

19*a*. Endopodites 2 to 4 trimerous . . . . . **Goniodelphys** (p. 486)
19*b*. Endopodites 2 to 4 bimerous . . . . . 20

20*a*. Antennule 8-segmented . . . . . **Ustina** (p. 486)
20*b*. Antennule 7-segmented . . . . . **Notopterophoroides** (p. 486)

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[2] *Agnathaner* Canu, based upon males only, is omitted from this key. The resemblance of the antenna to that of *Notodelphys*, with the unique degree of reduction of the mouthparts, furnish characters for the separation of this genus from all others.

21*a*. Body an inflated ovoid . . . . . **Ooneides** (p. 487)
21*b*. Body more elongate, vermiform . . . . . 22
22*a*. No thoracic appendages . . . . . **Ophioseides** (p. 487)
22*b*. One or more pairs of reduced swimming legs . . . . . 23
23*a*. One pair of reduced swimming legs present . . **Dysgenopsyllus** (p. 487)
23*b*. Four pairs of reduced swimming legs present . . . . . 24
24*a*. Swimming legs long, tapered, unsegmented processes lacking well-developed armature . . . . . 25
24*b*. Swimming legs short, compact, armed with short, stout spines . . . . 26
25*a*. Mouth appendages grouped at the midline . . . . . **Brementia** (p. 487)
25*b*. Mouth appendages displaced far laterally . . . . **Pholeterides** (p. 637)
26*a*. Brood sack occupies body region posterior to second legs. **Scolecimorpha** (p. 488)
26*b*. Brood sack occupies body region posterior to fourth swimming legs. **Scolecodes** (p. 632)

### Species Incerta Sedis

*Doropygus cylindriformis* (p. 586).

### Indeterminable Genera

*Salpicola* (p. 640).
*Ophioseidus* (p. 640).

## Genera not known from North America

### Genus *Agnathaner* Canu

*Agnathaner* Canu, 1891, p. 474 (type species, by original designation, *Agnathaner typicus* Canu, 1891); 1892, pp. 210–211.—T. Scott, 1907, p. 363.—Smith, 1909, p. 66.—G. Sars, 1921, pp. 38–39.—Schellenberg, 1922, p. 224.—Wilson, 1924, p. 17; 1932, p. 598.
*Agnathener* Leigh-Sharpe, 1934, p. 6.

#### *Agnathaner typicus* Canu

*Agnathaner typicus* Canu, 1891, p. 474 (type locality, Wimereux, France, in *Cynthia rustica*); 1892, pp. 211–212, pl. 17, figs. 1–10.—G. Sars, 1921, pp. 39–40, pl. 19.—Sewell, 1949, p. 188.

Distribution: Northern coast of France, Norway.
Hosts: *Cynthia rustica*, *Styelopsis grossularia* van Beneden.

#### *Agnathaner minutus* Canu

*Agnathaner minutus* Canu, 1891, p. 474 (type locality, Wimereux, France, in *Circinalium concrescens*); 1892, pp. 212–213, pl. 17, figs. 11–26.—Hartmeyer, 1911, p. 1736.—Sewell, 1949, p. 188.

Distribution: Northern coast of France.
Host: *Sidnyum turbinatum* (?=*Circinalium concrescens* Giard).

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## Genus *Prophioseides* Chatton and Brément

*Ophioseides* Chatton and Brément, 1911, p. 30 (part).
*Prophioseides* Chatton and Brément, 1915c, p. 155 (type species, by monotypy, *Ophioseides abdominalis* Chatton and Brément, 1911).

### *Prophioseides abdominalis* (Chatton and Brément)

*Ophioseides abdominalis* Chatton and Brément, 1911, pp. 30–33, fig. 1 (type locality, Banyuls-sur-Mer, France, in *Amaroucium densum* G.); 1915b, p. 134.—Schellenberg, 1922, p. 261.—Haranţ, 1931, p. 372.—Sewell, 1949, p. 183.

DISTRIBUTION: Banyuls, France.
HOST: *Amaroucium densum* G.

## Genus *Campopera* Schellenberg

*Campopera* Schellenberg, 1922, p. 259 (type species, by monotypy, *C. michaelseni* Schellenberg, 1922).—Wilson, 1932, p. 602.

### *Campopera michaelseni* Schellenberg

*Campopera michaelseni* Schellenberg, 1922, pp. 259–261, figs. 41–43 (type locality, Port Stanley, Falkland Islands, in *Paramolgula gigantea* (Cun.)).

DISTRIBUTION: Falkland Islands.
HOST: *Paramolgula gigantea.*

## Genus *Bonnierilla* Canu

*Paryphes* Kerschner, 1879, pp. 179–182 (not *Paryphes* Burmeister, 1835) (type species, by monotypy, *P. longipes* Kerschner, 1879).—von Martens, 1879, p. 44.—Giesbrecht, 1882a, pp. 325, 326.—Carus, 1885, p. 344.
*Bonnierilla* Canu, 1891, pp. 470, 473, 475 (type species, by monotypy, *Paryphes longipes* Kerschner, 1879); 1892, pp. 196–197.—Schellenberg, 1922, pp. 249–250.—Wilson, 1924, p. 18; 1932, p. 599.
*Bonneriella* Vosseler, 1894, p. 357.—Norman, 1905, p. 36.
*Bonnierella* Gurney, 1927, p. 480 (not *Bonnierella* Chevreux, 1900).
*Bonierilla* Sewell, 1949, pp. 164, 174.

### *Bonnierilla acollaris* Schellenberg

*Bonnierilla acollaris* Schellenberg, 1922, pp. 250–251, 266, fig. 29.—Sewell, 1949, p. 170 (type localities: Australia, Suez; in *Ascidia malaca* Traust., *A. glabra* Hartmr., *Ascidiella aspersa* (Müll.), *Pyura gangelion* (Sav.), *Styela canopus* (Sav.)).
*Bonnierella acollaris* Gurney, 1927, p. 480.
*Bonnierilla acollaris* Sewell, 1949, p. 174.
?*Bonnierilla scolaris* Sewell, 1949, p. 179.

DISTRIBUTION: Australia; Gulf of Suez.
HOSTS: *Ascidia glabra* Hartmr., *Ascidia malaca* Traust., *Ascidiella aspersa* (Müll.), *Pyura gangelion* (Savigny), *Styela canopus* (Savigny).

#### *Bonnierilla arcuata* Brément

*Bonnierilla arcuata* Brément, 1909, pp. 64–69, figs. 1–14 (type locality, Banyuls, France, in *Diplosoma spongiforme* Giard).—Hartmeyer, 1911, p. 1736.—Schellenberg, 1922, pp. 250, 266.—Harant, 1931, p. 370.

DISTRIBUTION: Coast of France.
HOST: *Diplosoma spongiforme* Giard.

#### *Bonnierilla armata* Schellenberg

*Bonnierilla armata* Schellenberg, 1922, pp. 252–253, 266, fig. 32 (type localities, Australia; West Africa; in *Molgula reducta* Hartmr., and *Polycarpa goréensis* Mchlsn).
*B.* [*onierilla*] *armata* Sewell, 1949, p. 174.

DISTRIBUTION: Australia; West Africa.
HOSTS: *Molgula reducta* Hartmr., *Polycarpa goréensis* (Mchlsn.).

#### *Bonnierilla brevipes* Schellenberg

*Bonnierilla brevipes* Schellenberg, 1922, pp. 251–252, 266, figs. 30–31 (type locality, Malay Archipelago, in *Polycarpa papillata* (Sluit.)).
*Bonierilla brevipes* Sewell, 1949, p. 163.

DISTRIBUTION: Malay Archipelago.
HOST: *Polycarpa papillata* (Sluit.).

#### *Bonnierilla longipes* (Kerschner)

*Paryphes longipes* Kerschner, 1879, pp. 179–182, pl. 3, fig. 10, pl. 4, figs. 1–10 (type locality, Bay of Muggia, Trieste, in *Cynthia* spp.).—Gourret, 1888, p. 1.—Graeffe, 1902, p. 40.—Sewell, 1949, p. 183.
*Bonnierilla longipes* Canu, 1891, p. 473; 1892, pp. 77–78, 197–198, pl. 9, figs. 4–13, pl. 10, figs. 1–8.—Norman, 1905, p. 36.—Hartmeyer, 1911, pp. 1734–1735.—Schellenberg, 1922, pp. 250, 266.—Harant, 1931, p. 370.—Sewell, 1949, p. 182.
*Bonnierella longipes* Gurney, 1933, p. 304.

DISTRIBUTION: Mediterranean; Atlantic coast of France.
HOSTS: *Clavelina lepadiformis*, *Cynthia lurida* Thor., *Cynthia* sp., *Pyura lurida*, *Pyura* sp.

### Genus *Notopterophorus* Leuckart

*Notopterophorus* Costa, 1840, p. 7 (nomen nudum).—Hope, 1851, p. 38 (nomen nudum).—Leuckart, 1859, pp. 241–247 (type species, *N. veranyi* Leuckart, 1859).—Thorell, 1859a, p. 6; 1859b, p. 336; 1860, p. 115.—M. Sars, 1861, p. 136.—Claus, 1864, p. 381.—Buchholz, 1869, pp. 125–126.—Calman, 1909, p. 103.—G. O. Sars, 1921, pp. 52–53.—Brehm, 1927, p. 490 (part).—Schellenberg, 1922, p. 254 (part).—Wilson, 1932, p. 602.
*Notopteropherus* Claus, 1875, p. 350.
*Doropygus* (*Notopterophorus*) Giesbrecht, 1882a, pp. 316–325 (part).
*Doropygus* Thorell, 1859a, pp. 43–46 (part).—Aurivillius, 1882a, p. 46.

### *Notopterophorus auritus* (Thorell)

*Doropygus auritus* Thorell, 1859a, pp. 50–52, pl. 7, pl. 8, fig. 10 (type locality, Sweden, in *Ascidia canina* Müll.); 1859b, pp. 339, 343; 1860, pp. 119, 123.—Hesse, 1866, pp. 54, 64.—Norman, 1869, p. 299.—Gerstaecker, 1870–1871, pp. 777, 801, pl. 11, figs. 12–22.—Brady, 1878, pp. 135–136, pl. 29, figs. 1–11.—Aurivillius, 1882a, pp. 55–56, pl. 6, fig. 13; 1882b, pp. 61, 112, pl. 13, fig. 12, pl. 15, figs. 1, 2; 1883, pp. 25–26, 57, 108, pl. 2, fig. 13, pl. 4, fig. 12, pl. 6, figs. 1, 2.—Norman, 1905, p. 36.—Norman and Scott, 1906, p. 202.—T. Scott, 1907, p. 364.—Vanhöffen, 1917, p. 224.

*Doropygus* (*Notopterophorus*) *elongatus* var. *auritus* Giesbrecht, 1882a, pp. 317, 328.—Carus, 1885, p. 343.—Pesta, 1909, p. 259.

*Notopterophorus auritus* Koehler, 1890, p. 138.—G. Sars, 1921, pp. 53–54, pl. 26.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 120, fig. 72.—Lang, 1948, p. 3.—Sewell, 1949, pp. 188, 191.

*Notopterophorus elongatus* var. *auritus* Schellenberg, 1922, pp. 254, 266.

DISTRIBUTION: Sweden, Norway; British Isles.

HOSTS: *Ascidia canina Müller, A. mentula, Phallusia mentula, P. obliqua, P. venosa.*

### *Notopterophorus micropterus* G. Sars

*Notopterophorus micropterus* G. Sars, 1921, p. 56, pl. 28, fig. 1 (type locality, Norway).—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 121, fig. 74.—Sewell, 1949, p. 191.

DISTRIBUTION: Norway.

HOST: *Ascidia mentula.*

### *Notopterophorus papilio* Hesse

*Notopterophorus papilio* Hesse, 1864, pp. 338–343, pl. 11, figs. 1–13 (type locality, France, in *Phallusia canina*); 1865, pp. 220–223.—Norman, 1869, p. 300; 1905, p. 36.—Gerstaecker, 1870–1871, pp. 776, 801.—Brady, 1878, pp. 142–144, pl. 31, figs. 3–12.—Richiardi, 1880, p. 147.—Koehler, 1890, pp. 131–134, 138, figs. 1, 4–8.—Schimkewitsch, 1893, pp. 200, 202; 1896, p. 339, pl. 14, figs. 30–32, pl. 16, figs. 56, 61.—Thompson, 1893, pp. 190–191, pl. 18, figs. 5, 6.—T. Scott, 1897, p. 148; 1901, p. 351; 1907, pp. 365–366; 1908, pp. 212–216.—Norman and Scott, 1906, p. 202.—Hartmeyer, 1911, p. 1735.—G. Sars, 1921, p. 55, pl. 27.—Schellenberg, 1922, p. 254, 267.—Harant, 1931, p. 372.—Marine Biological Association, 1931, p. 173.—Leigh-Sharpe, 1935, p. 48.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, pp. 120–121, fig. 73.—Sewell, 1949, p. 188.

*Doropygus* (*Notopterophorus*) *papilio* Giesbrecht, 1882a, pp. 316, 327.—Carus, 1885, p. 341.—Gourret, 1888, p. 1.—Pesta, 1909, p. 259.

*Notopterophorus pupilio* Hesse, 1869, p. 298.

*Doropygus* (*Notopterophorus*) *papilio* var. *massiliensis* Gourret, 1887, pp. 185–186; 1888, pp. 36–52, pl. 2, fig. 10, pl. 3, figs. 1, 2, 5, pl. 4, figs. 3, 4.—Sewell, 1949, p. 182.

DISTRIBUTION: Mediterranean to Norway; British Isles.

HOSTS: *Ascidia canina, A. mentula, Ciona canina, Phallusia mentula, P. oblique, P. venosa.*

### *Notopterophorus elongatus* Buchholz

*Notopterophorus elongatus* Costa, 1840, p. 7 (nomen nudum).—Hope, 1851, p. 38 (nomen nudum).—Claus, 1864, pp. 381–382 (nomen nudum).—Buchholz, 1869, pp. 127–136, pl. 8, fig. 6, pl. 9, fig. 6.—Brady, 1878, p. 144.—Kerschner, 1879, pp. 187–189, pl. 1, figs. 8, 9, pl. 3, fig. 3, pl. 5, figs. 13–17, pl. 6, figs. 1, 2.—Richiardi, 1880, p. 147.—Giesbrecht, 1882a, pp. 370–371, pl. 23, figs. 2–4, 11, pl. 24, fig. 7; 1892, p. 815.—Koehler, 1890, p. 132, figs. 2, 3, p. 138.—Graeffe, 1902, p. 39.—Norman, 1905, p. 36.—Brian, 1906, p. 144.—Schellenberg, 1922, pp. 254, 266–267.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 121.—Sewell, 1949, pp. 182, 188.

*Notopterophorus elongatus* var. *elongatus* Schellenberg, 1922, p. 254.

*Notopterophorus elatus* Costa, 1840, p. 7 (nomen nudum).—Hope, 1851, p. 38 (nomen nudum).—Claus, 1864, pp. 381–382 (nomen nudum).—Giesbrecht, 1882a, pp. 370–372, pl. 22, fig. 1, pl. 23, figs. 12–14, pl. 24, figs. 8, 10–15, 18–21; 1892, p. 815.—Norman, 1905, p. 36.—Brian, 1906, p. 144.—Harant, 1931, p. 372.

*Notopterophorus veranyi* Leuckart, 1859, pp. 241–247, pl. 6, figs. 2–8 (type locality, Nizza, in *Phallusia mammillaris*).—Thorell, 1859a, p. 6.—Hesse, 1864, p. 338.—Heller, 1866, p. 750.—Stossich, 1881, pp. 270–271.—Hartmeyer, 1911, p. 1735.

*Doropygus auritus* var. *elongatus* Aurivillius, 1882b, pp. 61–70, 112, pl. 15, fig. 3; 1883, pp. 57–66, 108, pl. 6, fig. 3.

*Doropygus* (*Notopterophorus*) *elongatus* Giesbrecht, 1882a, pp. 316, 327.—Carus, 1885, p. 343.—Canu, 1892, pp. 190–191.—Pesta, 1909, p. 259.

*Doropygus* (*Notopterophorus*) *elongatus* var. *elongatus* Giesbrecht, 1882a, pp. 316, 328.—Gourret, 1888, p. 1.—Pesta, 1909, p. 259.

*Doropygus* (*Notopterophorus*) *elongatus* var. *elatus* Giesbrecht, 1882a, pp. 316, 327.—Carus, 1885, p. 343.—Gourret, 1888, p. 1.—Canu, 1892, p. 191.—Pesta, 1909, p. 259.

[*Doropygus*] (*Notopterophorus*) *elatus* Canu, 1891, p. 472.

*Notopterophorus elongatus* var. *elatus* Koehler, 1890, p. 138.—Schellenberg, 1922, pp. 254, 266.

*Doropygus* (*Notopterophorus*) *elongatus* var. *maculatus* Gourret, 1887, p. 186; 1888, pp. 52–59, pl. 2, figs. 11–13; pl. 3, fig. 4; pl. 4, fig. 5.

?*Notopterophorus elongatus* var. *massiliensis* Sewell, 1949, p. 182.

DISTRIBUTION: Mediterranean to Sweden.

HOSTS: *Ascidia mentula, A. mammillata, Ascidiella aspersa, Clavellina lepadiformis, Phallusia mamillata, P. mammillaris, P. mentula, P. gelatinosa, Phallusiopsis mammillata.*

### *Notopterophorus* sp. Schimkewitsch

*Notopterophorus* sp. Schimkewitsch, 1896, p. 342, pl. 15, figs. 43, 44–46.

DISTRIBUTION: Roscoff, France.

HOSTS: *Ascidia sanguinolenta, Ciona intestinalis.*

## INDETERMINABLE SPECIES

### *Notopterophorus bombyx* Hesse

*Notopterophorus bombyx* Hesse, 1865, pp. 223–226 (type locality, coast of France, in *Ciona intestinalis*).—Gerstaecker, 1870–1871, pp. 776, 801.—Hartmeyer, 1911, p. 1735.

## Genus *Paranotodelphys* Schellenberg

*Paranotodelphys* Schellenberg, 1922, pp. 232–233 (type, hereby designated, *P. scutiformis* Schellenberg, 1922 [first species]).—Gurney, 1927, p. 480.—Wilson, 1932, pp. 598, 599.

*Pseudonotodelphys* Gurney, 1927, p. 480 (type species, by monotypy, *P. phallusiae* Gurney, 1927).—Wilson, 1932, p. 590.—Lang, 1948, p. 6.

?*Notodelphys* Lang, 1948, p. 6 (part).

### *Paranotodelphys scutiformis* Schellenberg

*Paranotodelphys scutiformis* Schellenberg, 1922, pp. 233–235, figs. 9–11 (type localities: Freemantle, Australia, Sharks Bay, Australia, Pajunga Islands; in *Ascidia malaca* Traust., *Ascidiella aspersa* (Müll.), *Ascidiella latesiphonica* Hartmr., *Ascidia gemmata* Sluit.).—Sewell, 1949, p. 174.

DISTRIBUTION: Australia, Pajunga Islands.

HOSTS: *Ascidia malaca* Traust., *Ascidiella aspersa* (Müll.), *Ascidiella latesiphonica* Hartmr., *Ascidia gemmata* Sluit.

### *Paranotodelphys gracilis* Schellenberg

*Paranotodelphys gracilis* Schellenberg, 1922, pp. 235–236, figs. 12–14 (type locality, Gulf of Suez, in *Rhodosoma verecundum* Ehrbg.).—Gurney, 1927, p. 480.—Sewell, 1949, pp. 169, 179.

DISTRIBUTION: Gulf of Suez.

HOST: *Rhodosoma verecundum* Ehrbg.

### *Paranotodelphys longicauda* Schellenberg

*Paranotodelphys longicauda* Schellenberg, 1922, pp. 236–237, figs. 15, 16 (type locality Gauss-Station, Deutsche Tiefsee Expedition, Antarktis [sic]).—Sewell, 1949, p. 174.

DISTRIBUTION: Antarctic.

### *Paranotodelphys phallusiae* (Gurney), new combination

*Pseudonotodelphys phallusiae* Gurney, 1927, pp. 480–482, fig. 120,a–m (type locality, Gulf of Suez, from collections in which *Phallusia nigra* was common).—Sewell, 1949, pp. 169, 179.

DISTRIBUTION: Gulf of Suez.

HOST: Not certainly known.

## Genus *Doroixys* Kerschner

*Doroixys* Kerschner, 1879, pp. 176–179 (type species, by monotypy, *D. uncinata* Kerschner, 1879).—T. Scott, 1907, p. 366.—Wilson, 1932, p. 601.

*Doroyxes* Giesbrecht, 1882a, pp. 325, 326.

### *Doroixys uncinata* Kerschner

*Doroixys uncinata* Kerschner, 1879, pp. 176–179, pl. 4, figs. 11–13, pl. 5, figs. 1–12 (type locality, Trieste, in *Amaroecium* spp.).—Della Valle, 1883, pp. 242–245, pl. [1], figs. 1, 2.—Carus, 1885, p. 343.—Gourret, 1888, p. 1.—Canu, 1891, p. 472; 1892, pp. 83–88, 202–203, pl. 14, figs. 1–14, pl. 15, figs. 1–11.—Graeffe, 1902, p. 40.—Norman, 1905, p. 36.—Hartmeyer, 1911, p. 1734.—Schellenberg, 1922, pp. 254, 266.—Harant, 1931, p. 370.—Sewell, 1949, pp. 183, 184, 188.

DISTRIBUTION: Mediterranean; northern coast of France.

HOSTS: *Amaroecium* spp., *Aplidium cristallinum*, *Aplidium gibbulosum*, *Fragarium areolatum*, *Diazona violacea*, *Perophora listeri*, *Botrylloides* spp., *Botryllus violatinctus*, *Glossoforum luteum*, *Amaroucium gibbulosum*, *Amaroucium mediterraneum*, *Parascidia areolata*, *Sidnyum turbinatum*, *Morchellium argus*, *Polyclinum aurantium*, *Amaroucium punctum*, *Amaroucium areolatum*.

## Genus *Lonchidiopsis* Vanhöffen

*Lonchidiopsis* Vanhöffen, 1917, pp. 224–229 (type species, by monotypy, *L. hartmeyeri* Vanhöffen, 1917).—Schellenberg, 1922, p. 259.—Wilson, 1932, p. 599.

### *Lonchidiopsis hartmeyeri* Vanhöffen

*Lonchidiopsis hartmeyeri* Vanhöffen, 1917, pp. 224–229, pl. [1], text figs. 1–7 (type locality, Sharks Bay, Australia, in *Ascidia sydneiensis* Stimpson).—Schellenberg, 1922, pp. 259, 268.

DISTRIBUTION: Australia.

HOST: *Ascidia sydneiensis* Stimpson.

## Genus *Botachus* Thorell

*Botachus* Thorell, 1859a, pp. 54–55 (type species, by monotypy, *B. cylindratus* Thorell, 1859a).—Claus, 1875, p. 350.—Giesbrecht, 1882a, pp. 325, 326.—Brehm, 1927, p. 490.—Wilson, 1932, p. 598.

### *Botachus cylindratus* Thorell

*Botachus cylindratus* Thorell, 1859a, pp. 55–56, pl. 9, fig. 12 (type locality, Sweden); 1859b, pp. 339, 342, 343; 1860, pp. 119, 121, 123.—Norman, 1869, pp. 299–300; 1905, p. 36.—Gerstaecker, 1870–1871, pp. 775, 801.—Brady, 1878, pp. 140–141, pl. 33, figs. 1–13.—Kerschner, 1879, pp. 189–190, pl. 2, figs. 1, 2, pl. 3, fig. 1.—Giesbrecht, 1882a, pp. 296, 297.—Aurivillius, 1882a, pp. 63–65, pl. 5, figs. 14–16; 1882b, p. 112; 1883, pp. 33–36, 108, pl. 1, figs. 14–16.—Della Valle, 1883, p. 244.—Carus, 1885, p. 343.—Gourret, 1888, p. 1.—Herdmann, 1889, pp. 248, 249.—Koehler, 1890, p. 137.—Thompson, 1889, p. 187; 1893, p. 190, pl. 18, figs. 3, 3a.—T. Scott, 1897, p. 148; 1901, p. 351; 1907, pp. 366–367.—Graeffe, 1902, p. 40.—Hartmeyer, 1911, p. 1735.—Sars, 1921, pp. 59–60, pl. 29.—Schellenberg, 1922, p. 267.—Hərant, 1931, p. 370.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 121, fig. 76.—Lang, 1948, p. 3.—Sewell, 1949, pp. 183, 188, 191.

*Botachus fusiformis* Buchholz, 1869, pp. 122–125, pl. 7, fig. 5, pl. 8, fig. 5.—Carus, 1885, p. 344.—Gourret, 1888, p. 1.—Gerstaecker, 1870–1871, pp. 776, 777, 804.—Koehler, 1890, p. 137, fig. 9.—Hartmeyer, 1911, p. 1735.—Sewell, 1949, p. 183.

DISTRIBUTION: Mediterranean to Sweden and Norway; British Isles.

HOSTS: *Ascidians*, *Ascidia canina*, *A. intestinalis*, *A. mentula*, *A. plebeia*, *Ciona intestinalis*, *Phallusia mentula*, *P. obliqua*, *P. mamillata*, *P. monacha*, *P. sp.*

INDETERMINABLE SPECIES

***Botachus fulvus* Hesse**

*Botachus fulvus* Hesse, 1869, p. 298 (type locality, coast of France, in *Ascidia canina*).—Gerstaecker, 1870–1871, pp. 777, 801.

***Botachus macroone* Hesse**

*Botachus macroone* Hesse, 1869, pp. 297–298 (type locality, coast of France, in *Ascidia canina*).—Gerstaecker, 1870–1871, pp. 777, 801.—Hartmeyer, 1911, p. 1735.

## Genus *Goniodelphys* Buchholz

*Goniodelphys* Buchholz, 1869, pp. 136–137 (type species, by monotypy, *G. trigona* Buchholz, 1869).—Claus, 1875, p. 350.—Giesbrecht, 1882a, p. 325.—Canu, 1891, p. 475.—Wilson, 1932, p. 599.

***Goniodelphys trigona* Buchholz**

*Goniodelphys trigonus* Buchholz, 1869, pp. 137–144, pl. 9, fig. 7, pl. 10, fig. 7 (*G. trigona*) (type locality, Naples, Italy).—Carus, 1885, p. 344.—Gerstaecker, 1870–1871, pp. 775, 804.—Grebnitskiĭ, 1873–1874, p. 247.—Hartmeyer, 1911, p. 1735.—Schellenberg, 1922, p. 254.—Sewell, 1949, p. 183.

DISTRIBUTION: Italy,? Black Sea.

## Genus *Ustina* Illg

*Ustina* Illg, 1951, pp. 30–34 (type species, *Ustina clarki* Illg, 1951).

***Ustina clarki* Illg**

*Ustina clarki* Illg, 1951, pp. 30–34, fig. 1 (type locality, Sagami Bay, Japan, in unidentified ascidian).

DISTRIBUTION: Japan.

HOST: Unidentified ascidian.

## Genus *Notopterophoroides* Schellenberg

*Notopterophoroides* Schellenberg, 1922, pp. 254–255 (type species, by subsequent designation, Lang, 1948, p. 7, *N. armadillo* Schellenberg).—Gurney, 1927, p. 480.—Wilson, 1932, p. 601.—Lang, 1948, p. 7.—Sewell, 1949, pp. 170, 174.—Illg, 1951, p. 34.

***Notopterophoroides armadillo* Schellenberg**

*Notopterophoroides armadillo* Schellenberg, 1922, pp. 255–256, figs. 33–35 (type localities: southwestern Australia, Pajunga Islands; in *Ascidia latesiphonica* Hartmr., *A. gemmata* Sluit.).—Lang, 1948, p. 7.—Sewell, 1949, p. 174.—Illg, 1951, p. 34.

DISTRIBUTION: Australia, Pajunga Islands.

HOSTS: *Ascidia latesiphonica* Hartmr., *Ascidia gemmata* Sluit.

#### *Notopterophoroides malacodermatus* Schellenberg

*Notopterophoroides malacodermatus* Schellenberg, 1922, pp. 256–257, figs. 36–37 (type locality, Gulf of Suez, in *Ascidia canelata* Cok.).—Gurney, 1927, p. 480.—Lang, 1948, p. 7.—Sewell, 1949, pp. 170, 179.—Illg, 1951, p. 34.

DISTRIBUTION: Suez.
HOST: *Ascidia canelata* Cok.

### Genus *Ophioseides* Giard

*Ophioseides* Giard, 1873, pp. 498–499 (type species, by monotypy, *O. apoda* Giard, p. 498).

#### *Ophioseides apoda* Giard

*Ophioseides apoda* Giard, 1873, pp. 498–499, 514, pl. 19, figs. 2, 3 (type locality, Roscoff, France, in *Astellium perspicuum*).—Chatton, 1909a, p. 19.—Hartmeyer, 1911, p. 1736.—Schellenberg, 1922, p. 261.
*Ophios des apoda* Giard, 1873, p. 514.

DISTRIBUTION: Roscoff, France.
HOST: *Astellium perspicuum.*

### Genus *Ooneides* Chatton and Brément

*Ooneides* Chatton and Brément, 1915b, pp. 136–137 (type species, by monotypy, *O. amela*, Chatton and Brément, 1915b).—Wilson, 1932, p. 603.

#### *Ooneides amela* Chatton and Brément

*Ooneides amela* Chatton and Brément, 1915b, pp. 137–143, figs. 1–4 (type locality, Banyuls-sur-Mer, France, in *Leptoclinum dentatum* Della Valle).—Harant, 1931, p. 372.—Sewell, 1949, p. 183.

DISTRIBUTION: Mediterranean coast of France.
HOST: *Didemnum dentatum* (=*Leptoclinum dentatum*).

### Genus *Dysgenopsyllus* Nicholls

*Dysgenopsyllus* Nicholls, 1944, pp. 59–60 (type species, by monotypy, *D. reevesbyensis* Nicholls, 1944).

#### *Dysgenopsyllus reevesbyensis* Nicholls

*Dysgenopsyllus reevesbyensis* Nicholls, 1944, pp. 59–60, fig. 27 (type locality, Reevesby Island, South Australia; type in South Australian Museum).—Sewell, 1949, p. 174.

DISTRIBUTION: South Australia.

### Genus *Brementia* Chatton and Brément

*Brementia*, Chatton and Brément, 1915a, pp. 129–130 (type species, by monotypy, *B. balneolensis* Chatton and Brément, 1915a).—Wilson 1932, p. 601.

#### *Brementia balneolensis* Chatton and Brément

*Brementia balneolensis* Chatton and Brément, 1915a, pp. 130–134, figs. 1, 2 (type locality, Banyuls-sur-Mer, France, in *Leptoclinum commune* Della Valle).—Harant, 1931, p. 370.—Sewell, 1949, p. 183.

DISTRIBUTION: Mediterranean coast of France.
HOST: *Didemnum fulgens* (=*Leptoclinum commune*).

### Genus *Scolecimorpha* G. Sars

*Ophioseides* Chatton, 1909a, p. 12 (type species, by original designation, *O. joubini* Chatton, 1909a).—Schellenberg, 1922, p. 261.
*Scolecimorpha* G. Sars, 1926, pp. 1, 3 (type species, by monotypy, *S. insignis* G. Sars, 1926).—Henderson, 1931, p. 217 (part).—Wilson, 1932, p. 601.

Remarks: The species of Sars and of Chatton, as readily established by reference to the figures published with each description, are obviously congeneric, if not conspecific. Accordingly they are here united in Sars' genus, since the tangled nomenclatural history of the name *Ophioseides* could not possibly warrant its retention for these forms.

#### *Scolecimorpha joubini* (Chatton), new combination

*Ophioseides joubini* Chatton, 1909a, pp. 14–18, figs. 1–8 (type locality, Banyuls-sur-Mer, France in *Microcosmus sabattieri* Roule); 1909b, pp. 482–484, fig. [1].—Hartmeyer, 1911, p. 1734.—Chatton and Brément, 1915b, p. 134; 1915c, pp. 150–152, figs. 3, 4.—Schellenberg, 1922, pp. 261, 268.—Harant, 1931, p. 372.—Sewell, 1949, p. 183.

DISTRIBUTION: France, New Zealand.
HOSTS: *Microcosmus sulcatus* (=*M. sabattieri*), *Cnemidocarpa cerea* Sluiter, *Pyura trita* Sluiter.

#### *Scolecimorpha insignis* G. Sars

*Scolecimorpha insignis* G. Sars, 1926, pp. 1–12, pls. 1, 2 (type locality, Trondhjem Fjord, Norway, in *Polycarpa pomaria*).—Henderson, 1931, p. 224.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 125, fig. 86.

DISTRIBUTION: Trondhjem Fjord, Norway.
HOST: *Polycarpa pomaria.*

## Genera with North American Representatives

### Genus *Notodelphys* Allman

*Notodelphys* Allman, 1847a, p. 2 (type, by monotypy, *N. ascidicola* Allman, 1847 [indeterminable species]).—Dana, 1853, p. 1443.—Leuckart, 1859, p. 247.—Thorell, 1859a, pp. 26–30.— Gerstaecker, 1863, p. 404.—Claus, 1875, p. 350.—Richiardi, 1880, p. 147.—Giesbrecht, 1882a, pp. 325, 326.—Calman, 1909, p. 103.—Smith, 1909, p 66.—G. Sars, 1921, pp. 30–31.—Schellenberg, 1922, pp. 225–227.—Brehm, 1927, p. 490.—Lang, 1948, pp. 4–6.
*Notodelphis* Carus, 1885, p. 341.

This genus embraces the forms least modified in the direction of endoparasitism. The body is slender and readily mobile. The head is broader than long, with a long rostrum triangular in outline. The metasome is dorsoventrally depressed. The thoracic segment of the first swimming legs is free in most well known species. The segment is markedly narrower than that succeeding. The second thoracic

segment is broader than the third. The brood pouch arises from the fourth segment, and incorporates the segment of the fifth legs. The furca bears terminally four long plumose setae and also a short unornamented seta on each of the outer and inner margins. The usual ranked length relation of the terminal setae is: outermost, innermost, outer of the two medial setae, inner of the two medial setae.

The antennule is strongly developed, somewhat shorter than the head. In the female it is usually 15-segmented. In the North American species coalescence of segments reduces the number to twelve and ten. The 10- and 12-segmented antennae of the male are bilaterally modified into weakly prehensile appendages with elongate terminal segments. The joint is usually between the ninth and tenth segments. The second antenna is basically trimerous; usually there is a high degree of coalescence of the two proximal segments. First segment bears two plumose setae, exceptionally one. The terminal segment bears on the inner side three bent setae, of which the most lateral arises on a sensory prominence. The surface of this segment is ornamented with a row of denticles. On the inner side and behind the terminal hook are inserted five to six setae, three of which are curved terminally and unornamented.

The coxopodite of the mandible is expanded medially as the masticatory lamella, this with characteristically sculptured medial margin. The basipodite usually bears one seta, laterally inserted. The endopodite is bimerous, the basal segment primitively with four marginal setae, the distal segment with ten. The exopodite exhibits varyingly preserved indications of pentamerism, and usually supports five setae. The terminal seta of the expopodite is usually much stouter than the others.

The coxopodite of the maxillule bears two endites. Nine or ten masticatory setae are borne on the first, a single seta on the second. The basipodite has two to three inner setae. The endopodite is somewhat slenderer than, but about as long as, the exopodite. On the endopodite arise five to six setae. The exopodite bears four setae.

The maxilla is characterized by a very stout process in the form of a sickle-hook on the second segment. It is longer than the accompanying setae.

The maxilliped is trimerous, spatulate in outline. The basal segment is, in some instances, divided again by a transverse furrow. The second segment is somewhat slenderer and much shorter than the first and mostly longer than wide. It bears on the inner side a stout seta, somewhat hooklike. The third segment is truncate, triangular and small. From it arises also a strong hook-spine and one to two less stout plumose setae.

The swimming legs are well developed. The rami are trimerous and of approximately equal length. The representative ornamentation

of the four pairs of swimming legs would be approximated in the following generalized formulation, but certain species may depart from it in particulars. In the first legs, the intercoxal plate is well developed and the coxopodite bears a sizable medial seta; the basipodite bears a lateral seta and distal medial stout spine. The first two segments of the exopodite bear each a lateral spine and medial seta. The distal segment bears three lateral spines, a terminal spine and seta, and three medial setae. The two basal segments of the endopodite each bear a medial seta. The terminal segment bears four medial setae, an apical seta, and a lateral seta. In the second and third legs there is added one medial seta on the terminal segment of the exopodite and one medial seta on the second segment of the endopodite. The third legs are like the second. In the fourth legs the condition of the second legs is altered by the removal of one lateral spine from the terminal segment of the exopodite and one medial seta from the terminal segment of the endopodite.

The fifth legs are bimerous. The basal segment is much expanded laterally to afford insertion for a short seta. The terminal segment bears a reduced spine and a seta, or a solitary seta.

The caudal rami are subcylindrical, with highly developed ornamentation of long plumose setae.

The genus *Notodelphys* as here considered retains its classic description with the most minor of emendations. Obvious coalescence of segments in two observable steps in the North American species provides for the characterization of the antennule as varying from 10-segmented to 15-segmented. The armature of the distal segment of the fifth legs varies from one to two setae or a spine and seta. Lack of availability of suitable specimens of the subtly differentiated European species leads me to accept the results of the major workers on the genus—Thorell, Aurivillius, G. Sars, and Schellenberg—and the diagnoses and key presented here are derived directly from their conclusions.

Stock (1951) has made an important correction in the interpretation of the body segmentation. Most authors have stated that the thoracic segment of the first swimming legs is fused with the head. On the contrary, in *N. rufescens*, *N. agilis*, *N. elegans* and in *N. weberi*, Stock finds this to be a free segment. Material he has kindly provided for the U. S. National Museum of *N. rufescens* confirms this and I have further been able to verify the condition in European specimens of *N. allmani*, *N. elegans*, and *N. prasina* in the collections of the Museum.

*Notodelphys* is a neatly delimited natural group. All the species which have received adequate description show very close affinity. Some species have had to be considered *species inquirendae*, including

the type of the genus. Examination of the recorded occurrence of the group presents some facts of zoogeographic interest and also emphasizes the great hiatus in knowledge of the ascidicolous copepods from the Pacific and Indo-Pacific regions.

The majority of species are known from Europe, the distribution of most ranging from the waters off Scandinavia around into the Mediterranean. No species is known to occur in great abundance on both sides of the Atlantic. There is a West African and a South African species, and a species from Patagonia completes the Atlantic circle. All of these species share particularly consistent anatomical features, and specific differentiation of them is, in the main, on very refined characteristics. Equally closely affiliated are three species known only from the Gulf of Suez. By contrast, there exists a North American complement of two species, very well differentiated from this larger stock. However the American forms are equivalently subtly separated *inter se*, with a remarkable parallelism thus exhibited in specific differentiation in two major subdivisions of the genus.

The North American forms are the only species that exhibit less than fifteen antennular segments and present an armature of the distal segment of the fifth leg reduced to a single seta. They obviously represent a distinctive genetic stock, and speculation on the zoogeographic aspects of the mechanisms of evolutionary differentiation is inviting. The necessity for increased knowledge of the distribution of the ascidicoles is thus here demonstrated. The available record is most fragmentary for such a readily available group of organisms.

### Key to the species of *Notodelphys*, based upon females

| | | |
|---|---|---|
| 1*a*. | Terminal segment of fifth leg with a single seta | 2 |
| 1*b*. | Terminal segment of fifth leg with a seta and a spine | 3 |
| 2*a*. | Antennule 10-segmented | **monoseta** (p. 496) |
| 2*b*. | Antennule 12-segmented | **affinis** (p. 503) |
| 3*a*. | Contour of last abdominal segment triangular | **parva** (p. 494) |
| 3*b*. | Contour of last abdominal segment rectangular | 4 |
| 4*a*. | Furca markedly shorter than last abdominal segment | **prasina** (p. 494) |
| 4*b*. | Furca as long as or longer than last abdominal segment | 5 |
| 5*a*. | Furca as long as last abdominal segment | 6 |
| 5*b*. | Furca markedly longer than last abdominal segment | 7 |
| 6*a*. | Last abdominal segment shorter than that preceding | **squamifera** (p. 495) |
| 6*b*. | Last abdominal segment longer than that preceding | **dentata** (p. 493) |
| 7*a*. | Furca twice as long as last abdominal segment | 8 |
| 7*b*. | Furca 1¼ to 1½ times as long as last abdominal segment | 9 |
| 8*a*. | Lateral seta at middle of the furca | **agilis** (p. 496) |
| 8*b*. | Distance of lateral seta from apex of the furca about equal to the width of the furca | **ciliata** (p. 493) |

9*a*. Distance of lateral seta of furca from the nearest terminal seta less than half the length of the furca but greater than the width of the furca . . 10
9*b*. Distance of lateral seta of furca from the nearest terminal seta not greater than the width of the furca . . . . . 14
10*a*. Outer margin of first segment of first exopodite ornamented with conspicuous spines or hairs . . . . . 11
10*b*. Outer margin of first segment of first exopodite entire or inconspicuously ornamented . . . . . 13
11*a*. Ornamentation of outer border of first segment of first exopodite consisting of long hairs . . . . . **patagonica** (p. 494)
11*b*. Ornamentation of outer border of first segment of first exopodite consisting of dense denticulation . . . . . 12
12*a*. Posterolateral corners of cephalic segment much produced . **weberi** (p. 495)
12*b*. Posterolateral corners of cephalic segment not much produced. **allmani** (p. 492)
13*a*. Claw of the second antenna one-half as long as the concave side of the third segment . . . . . **rufescens** (p. 495)
13*b*. Claw of second antenna one-third as long as the concave side of the third segment . . . . . **caerulea** (p. 493)
14*a*. Third segment of second antenna about one-third as broad as greatest breadth of the second segment . . . . . **pachybrachia** (p. 494)
14*b*. Third segment of second antenna one-half as broad as greatest breadth of the second segment . . . . . 15
15*a*. Greatest width of third segment of second antenna about two-thirds the length of the terminal claw . . . . . **tenera** (p. 495)
15*b*. Greatest width of third segment of second antenna about equal to the length of the terminal claw . . . . . **elegans** (p. 493)

## Species not known from North America

### *Notodelphys allmani* Thorell

*Notodelphys ascidicola* Allman, 1847, pp. 2–6, pl. 1, pl. 2, figs. 15–22 (part).
*Notodelphys allmanni* Thorell, 1859a, pp. 31–35, pl. 1, fig. 1, pl. 2, fig. 1 (type locality, Sweden, in *Ascidia canina* Müller, *A. mentula*); 1859b, pp. 338, 342, 343.—Claus, 1880, p. 553.—Aurivillius, 1882a, pp. 58–59; 1882b, pp. 81–82, 111; 1883, pp. 28–29, 77–78, 107.—T. Scott, 1888, p. 238.—Koehler, 1890, p. 138.—Canu, 1891, p. 472.—Lang. 1948, p. 2; 1951, fig. 5, pl. 1, fig. 1.
*Notodelphys allmani* Thorell, 1860, pp. 117, 121, 123.—Gerstaecker, 1870–1871, pp. 777, 801, pl. 11, figs. 1–11.—Grebnitskiĭ, 1873–1874, pp. 218, 242–245.—Möbius, 1875, p. 275.—Brady, 1878, pp. 126–129, pl. 25, figs. 1–10.—Kerschner, 1879, pp. 182–183.—Richiardi, 1880, p. 147.—Herdman, 1889, p. 248.—Canu, 1892, pp. 81–83, 188, pl. 13, figs. 1–6.—Thompson, 1889, p. 185; 1893, p. 189, pl. 17, fig. 7.—T. Scott, 1897, p. 148; 1900, p. 386; 1901, p. 351; 1906, p. 362; 1907, pp. 361–362.—Graeffe, 1902, p. 39.—Norman, 1905, p. 36.—Norman and Scott, 1906, p. 201—Hartmeyer, 1911, p. 1735.—G. Sars, 1921, pp. 31–33, pls. 15–16.—Schellenberg, 1922, pp. 227, 262.—Harant, 1931, p. 371.—Marine Biological Association, 1931, p. 172.—Gurney, 1933, p. 304.—Leigh-Sharpe, 1935, p. 48.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 117, fig. 66.—Sewell, 1949, pp. 182, 184, 188, 190.—Stock, 1950, p. 42; 1951, p. 3.

*Notodelphys mediterranea* Buchholz, 1869, pp. 111–114, pl. 5, fig. 1, pl. 6, fig. 1 (type locality, Naples, Italy).—Gerstaecker, 1870–1871, pp. 775, 804.—Kerschner, 1879, p. 184.
*Notodelphys mediterraneus* Hartmeyer, 1911, p. 1735.
*Notodelphis allmani*, Carus, 1885, p. 341.—Gourret, 1888, p. 1.

DISTRIBUTION: Mediterranean to Norway and Sweden; Black Sea; British Isles.

HOSTS: *Ascidia affinis*, *A. canina*, *A. mammillata*, *A. mentula*, *A. sydneiensis* Stps., *A. virginea*, *A. venosa*, *Ascidiella aspersa* (Müller), *A. opalina*, *Ciona canina*, *C. intestinalis*, *C. papillosa*, *Phallusia cristata*, *P. conchilega*, *P. mammillata*, *P. fumigata* Grube, *P. intestinalis*, *P. obliqua*, *P. virginea*, *Phallusia* sp., large ascidians.

#### *Notodelphys caerulea* Thorell

*Notodelphys caerulea* Thorell, 1859a, pp. 37–39, pl. 3, pl. 4, fig. 4 (type locality, Sweden, in *Ascidia venosa* Müller); 1859b, pp. 338–339, 343; 1860, pp. 118, 123.—Norman, 1869, p. 299; 1905, p. 36.—Aurivillius, 1883, pp. 30, 79–80, 107, pl. 1, fig. 17.—Hartmeyer, 1911, p. 1735.—G. Sars, 1921, pp. 34–35, pl. 17, fig. 2.—Shellenberg, 1922, p. 227.—Lang, 1948, p. 2.—Stock, 1951, p. 3.
*Notodelphys coerulea* Gerstaecker, 1870–1871, pp. 775, 801.—Aurivillius, 1882a, p. 60; 1882b, pp. 83–84, 111.—Norman and Brady, 1909, p. 400.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 117.—Sewell, 1949, p. 188.
*Notodelphys cerulaea* Brady, 1878, p. 130, pl. 27, figs. 10–13.

DISTRIBUTION: Atlantic coast of Europe to Norway and Sweden; British Isles.

HOSTS: *Ascidia parallelogramma*, *A. venosa* Müller, *A. virginea*, *Corella parallelogramma*, *Phallusia virginea*.

#### *Notodelphys ciliata* Schellenberg

*Notodelphys ciliata* Schellenberg, 1922, pp. 228–229, fig. 2 (type locality, Gulf of Suez, in *Phallusia nigra* Sow.).—Gurney, 1927, p. 480.—Sewell, 1949, pp. 169, 179.

DISTRIBUTION: Gulf of Suez.

HOST: *Phallusia nigra* Sow.

#### *Notodelphys dentata* Schellenberg

*Notodelphys dentata* Schellenberg, 1921, pp. 3–6, figs. 1–4 (type locality, Norway, in *Rhopalaea nordgaardi* Hartmr.).—Schellenberg, 1922, p. 227.

DISTRIBUTION: Norway.

HOST: *Rhopalaea nordgaardi* Hartmr.

#### *Notodelphys elegans* Thorell

*Notodelphys elegans* Thorell, 1859a, pp. 39–40, pl. 4, fig. 5 (type locality, Sweden, in *Ascidia intestinalis* (Müller)); 1859b, pp. 339, 343; 1860, pp. 118, 123.—Gerstaecker, 1870–1871, pp. 776, 801.—Möbius, 1873, p. 116; 1875, pp. 274–275.—Brady, 1878, p. 126.—? Kerschner, 1879, p. 184.—Richiardi, 1880,

p. 147.—Aurivillius, 1882b, pp. 78–81, 111, pl. 15, figs. 14–18, pl. 16, figs. 1–3; 1883, pp. 74–77, 107, pl. 6, figs. 14–18, pl. 7, figs. 1–3.—Canu, 1891, p. 472; 1892, p. 189.—Hartmeyer, 1911, p. 1735.—G. Sars, 1921, p. 37, pl. 18, fig. 2.—Schellenberg, 1922, p. 227.—Harant, 1931, p. 371.—Klie, 1933, p. 16.—Pesta, 1934, pp. 10–11, fig. 7.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, pp. 117–118.—Lang, 1948, p. 2.—Sewell, 1949, pp. 182, 188, 190.—Stock, 1951, p. 1.

*Notodelphis elegans* Carus, 1885, p. 341.—Gourret, 1888, p. 1.

DISTRIBUTION: Mediterranean to Norway and Sweden; British Isles.

HOSTS: *Ascidia canina, Ciona intestinalis.*

#### *Notodelphys pachybrachia* Schellenberg

*Notodelphys pachybrachia* Schellenberg, 1922, pp. 231, 262, figs. 5–6 (type locality, Gulf of Suez, in *Ascidia canelata*).—Gurney, 1927, p. 480.—Sewell, 1949, pp. 169, 179.

DISTRIBUTION: Gulf of Suez.

HOST: *Ascidia canelata* (Sav. Ok.).

#### *Notodelphys parva* Schellenberg

*Notodelphys parva* Schellenberg, 1922, pp. 231–232, 263, figs. 7, 8 (type locality, Gulf of Suez, in *Pyura momus, Polycarpa ehrenbergi*).—Gurney, 1927, p. 480.—Sewell, 1949, pp. 169, 179.

DISTRIBUTION: Gulf of Suez.

HOSTS: *Pyura momus* Sow., *Polycarpa ehrenbergi* Hartmr.

#### *Notodelphys patagonica* Schellenberg

*Notodelphys patagonica* Schellenberg, 1922, pp. 228, 263, fig. 1 (type locality, Patagonia, in *Ascidia tenera*).—Lang, 1948, pp. 4–5.

DISTRIBUTION: Patagonia.

HOST: *Ascidia tenera* Herdm.

#### *Notodelphys prasina* Thorell

*Notodelphys prasina* Thorell, 1859a, pp. 41–42, pl. 5, fig. 7; 1859b, p. 339; 1860, pp. 118, 123.—Norman, 1869, p. 299.—Gerstaecker, 1870–1871, pp. 776–777, 801.—Brady, 1878, pp. 131–132, pl. 30, figs. 11–15.—Kerschner, 1879, pp. 183–184, pl. 6, fig. 16.—Giesbrecht, 1882a, pp. 295–296.—Aurivillius, 1882b, pp. 84–87, 111, pl. 16, figs. 4–7; 1883, pp. 32–33, 80–91, 107, pl. 7, figs. 4–7.—T. Scott, 1897, p. 148; 1900, p. 386; 1901, p. 351.—Graeffe, 1902, p. 39.—Norman, 1905, p. 36.—Norman and Scott, 1906, p. 202.—T. Scott, 1907, p. 362—Hartmeyer, 1911, p. 1735.—G. Sars, 1921, pp. 37–38, pl. 18, fig. 3.—Schellenberg, 1922, pp. 227, 263.—Harant, 1931, p. 371.—Marine Biological Association, 1931, p. 173.—Leigh-Sharpe, 1935, p. 48.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 118, fig. 67.—Lang, 1948, p. 2.—Sewell, 1949, pp. 182, 188, 190.

*Notodelphys pusilla* Buchholz, 1869, pp. 115–116, pl. 6, fig. 2.—Gerstaecker, 1870–1871, pp. 775, 804.—Hartmeyer, 1911, p. 1735.

*Notodelphis prasina* Carus, 1885, p. 341.—Gourret, 1888, p. 1.

DISTRIBUTION: Mediterranean to Norway and Sweden; British Isles.

HOSTS: *Ascidia canina*, *A. mentula* Müller, *Ascidiella aspersa*, *Ciona intestinalis*, *Phallusia mammilata* (Cuvier), *P. mentula*, *Phallusia* sp.

#### *Notodelphys rufescens* Thorell

*Notodelphys rufescens* Thorell, 1859a, pp. 35–36, pl. 2, fig. 2; 1859b, pp. 338, 343; 1860, pp. 117–118, 123.—Gerstaecker, 1870–1871, pp. 775, 801.—Kerschner, 1879, p. 183, pl. 1, figs. 1–3, pl. 2, figs. 7, 8, 10, pl. 3, fig. 4, pl. 6, figs. 13–15.—Aurivillius, 1882a, pp. 56–60; 1882b, pp. 82–83, pl. 16, fig. 8; 1883, pp. 29–30, 78–79, 107, pl. 7, fig. 8.—Graeffe, 1902, p. 39.—Hartmeyer, 1911, p. 1735.—G. Sars, 1921, pp. 33–34, pl. 17, fig. 1.—Schellenberg, 1922, pp. 227, 263.—Hansen, 1923, p. 22.—Stephensen, 1929, p. 6,—Harant, 1931, p. 372.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 117.—Stephensen, 1940, p. 20.—Lang, 1948, p. 2.—Sewell, 1949, pp. 182, 190, 193.—Stock, 1951, pp. 1–3, figs. 1–7.

*Notodelphis rufescens* Carus, 1885, p. 341.—Gourret, 1888, p. 1.

DISTRIBUTION: Mediterranean to Norway and Sweden; Faroes.

HOSTS: *Ascidia aspersa* Müller var.?, *A. conchilega*, *A. cristata* Heller, *A. obliqua*, *Ascidiella aspersa*, *A. scabra*, *Phallusia conchilega*, *P. obliqua*.

#### *Notodelphys squamifera* Schellenberg

*Notodelphys squamifera* Schellenberg, 1922, p. 230, figs. 3, 4 (type locality, West Africa, in *Microcosmus senegalensis* Mchlsn.)

DISTRIBUTION: West Africa.

HOSTS: *Microcosmus senegalensis* Mchlsn.

#### *Notodelphys tenera* Thorell

*Notodelphys tenera* Thorell, 1859a, pp. 36–37, pl. 3, fig. 3; 1859b, pp. 338, 343; 1860, pp. 118, 123.—Gerstaecker, 1870–1871, pp. 777, 801.—Richiardi, 1880, p. 147.—Aurivillius, 1882b, pp. 70–78, 111, pl. 15, figs. 4–13; 1883, pp. 66–74, 107, pl. 6, figs. 4–13.—Hartmeyer, 1911, p. 1735.—G. Sars, 1921, p. 36, pl. 18, fig. 1.—Schellenberg, 1922, pp. 227, 263.—Harant, 1931, p. 372.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 117.—Lang, 1948, p. 2.—Sewell, 1949, p. 182.—Lang, 1951, fig. 6.

*Notodelphis tenera*, Carus, 1885, p. 341.—Gourret, 1888, p. 1.

DISTRIBUTION: Mediterranean to Norway and Sweden.

HOSTS: *Ascidia canina* Müller, *A. mammillata* Cuvier, *A. mentula*, *A. obliqua*, *Ciona intestinalis*, *Phallusia mentula*, *P. obliqua*.

#### *Notodelphys weberi* Stock

*Notodelphys weberi* Stock, 1950, pp. 37–42, figs. 1–3 (type locality, Knysna, South Africa, in *Ascidia canaliculata* Heller).

DISTRIBUTION: South Africa.

HOST: *Ascidia canaliculata* Heller.

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### North American Species

#### *Notodelphys agilis* Thorell

*Notodelphys agilis* Thorell, 1859a, pp. 40–41, pl. 4, pl. 5, figs. 5a–6 (type locality, Sweden, in *Ascidia parallelogramma, A. mentula, A. canina, A. aspersa*); 1859b, pp. 338, 343; 1860, pp. 117, 123.—Gerstaecker, 1870–1871, pp. 775–777, 801.—Möbius, 1875, p. 274.—Brady, 1878, pp. 130–131, pl. 26, figs. 1–10.—Claus, 1880, p. 553.—Aurivillius, 1882a, pp. 60–62; 1882b, p. 111; 1883, pp. 30–32, 107; 1885a, p. 230; 1885b, p. 282; 1886, p. 44.—Giesbrecht, 1882b, p. 88.—Dalla Torre, 1889, p. 86.—Canu, 1891, p. 472; 1892, pp. 78–81, pl. 12, figs. 1–8.—Timm, 1894, p. 396.—T. Scott, 1888, p. 238; 1897, p. 148; 1901, p. 351; 1906, p. 362; 1907, p. 362.—Norman, 1905, p. 36.—Norman and Brady, 1909, p. 400.—Hartmeyer, 1911, pp. 1734–1735.—Wilson, 1920, p. 15.—G. Sars, 1921, pp. 35–36, pl. 17, fig. 3.—Schellenberg, 1922, pp. 227, 262.—Harant, 1931, p. 371.— Wilson, 1932, p. 387, fig. 238.—Gray, 1933, p. 519.—Gurney, 1933, p. 303.—Pesta, 1934, p. 10, fig. 6.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 117.—Lang, 1946, p. 9, fig. 3; Lang, 1948, pp. 2, 20–22, fig. 16.—Sewell, 1949, pp. 157, 158, 184, 188, 190.—Stock, 1951, p. 1.

*Notodelphis agilis* Herdman, 1891, p. 207.

Distribution: Mediterranean and Atlantic coasts of Europe, British Isles; ? North America, Atlantic coast.

Hosts: *Ascidia parallelogramma, A. mentula, A. canina, A. aspersa, A. virginea, A sordida, A. obliqua, Ascidiella aspersa, Ascidiella opalina, Ascidiella patula, Caesira socialis, Ciona intestinalis, Corella parallelogramma, Molgula ampulloides* (*Bened.*), *M. holtiana* Herdman, *M. socialis* Alder, *Phallusia mentula, P. obliqua, Polycarpa comata* (Ald.), *Polycarpa gracilis.*

Remarks: Published records assign this species to the North American fauna. Some of the reported occurrences have been checked and the specimens upon which they were based have been found to be representatives of other species, hence no authoritative material was available for the present study. The diagnostic features of the species were illustrated by G. Sars (1921, pl. 17, fig. 3).

#### *Notodelphys monoseta* Pearse

Figure 1

*Notodelphys monoseta* Pearse, 1947, p. 7, figs. 36–40 (type locality, Beaufort, N. C., in *Ascidia interrupta* Heller).

Specimens examined:

North Carolina

From *A. interrupta:*

Beaufort, dredged, May 25, 1946, A. S. Pearse, holotypic female, allotypic male, 6 females, 3 males.

Description: Female (fig. 1,*a–o*): General features: The depressed body (fig. 1,*a*) is 10-segmented. The metasome consists of a cephalic

segment, three free segments bearing the first three pairs of swimming legs, and a much expanded incubatory segment which bears the fourth and fifth legs. The urosomal portion of the body consists of five segments. The first of these bears the oviducal apertures and it is the shortest of the five. The succeeding four are subequal in length. The last bears the caudal rami which are about one and a third times as long as the fifth segment.

The first free thoracic segment lacks epimera. The head complex and free segments 2 and 3 are much expanded laterally and somewhat ventrally into well-developed epimera.

The rostrum (fig. 1,*b*) is conspicuous, extending between the bases of the antennules as a posteriorly arching tapered beak. The apex is obtuse and the rostrum is considerably flattened.

Head appendages: The antennule (fig. 1,*c*) is composed of 10 segments. All are well sclerotized although some traces are apparent of a fundamentally greater number of segments. The basal segments are much enlarged in diameter and the appendage tapers by some telescopic intervals and some gradual transitions to an extremely small subquadrate apical segment. The sixth segment is the longest and bears indentations of the integument indicating coalescence of probably three primary subdivisions. The basal diameter of the segment is about two thirds the length and roughly three-fifths the diameter of the proximal segment of the appendage. Details of setation are not readily determinable from the available specimens but there is indication of possession of markedly distinctive features.

The segments of the trimerous antenna (fig. 1,*d*) are all relatively short and stout. The two proximal segments are closely coalesced and at the point of union on the inner side of the right-angled flexure which the antenna usually presents there are inserted on the proximal segment two well-developed setae. The articulation of the two basal segments is diagonal so that the second segment has an inner margin (relative to the flexure) of about half the diameter of the segment. The outer margin slightly exceeds the diameter of the segment. A short distance subterminally on the outer margin there is inserted a reduced seta. The second segment is widest. The proximal segment tapers sharply toward the base.

The length of the distal segment (fig. 1,*e*) is about two times its greatest width. The distal margin is widely truncate. The outer third of this margin participates in the complicated articulation of a terminal, stout, tapered, curved spine, the length of which somewhat exceeds the greatest diameter of the segment. Inserted in the region of articulation of the spine are three curved setae, graduated in length from the longest which about equals the spine. There are two additional short setae inserted on the distal margin of the segment.

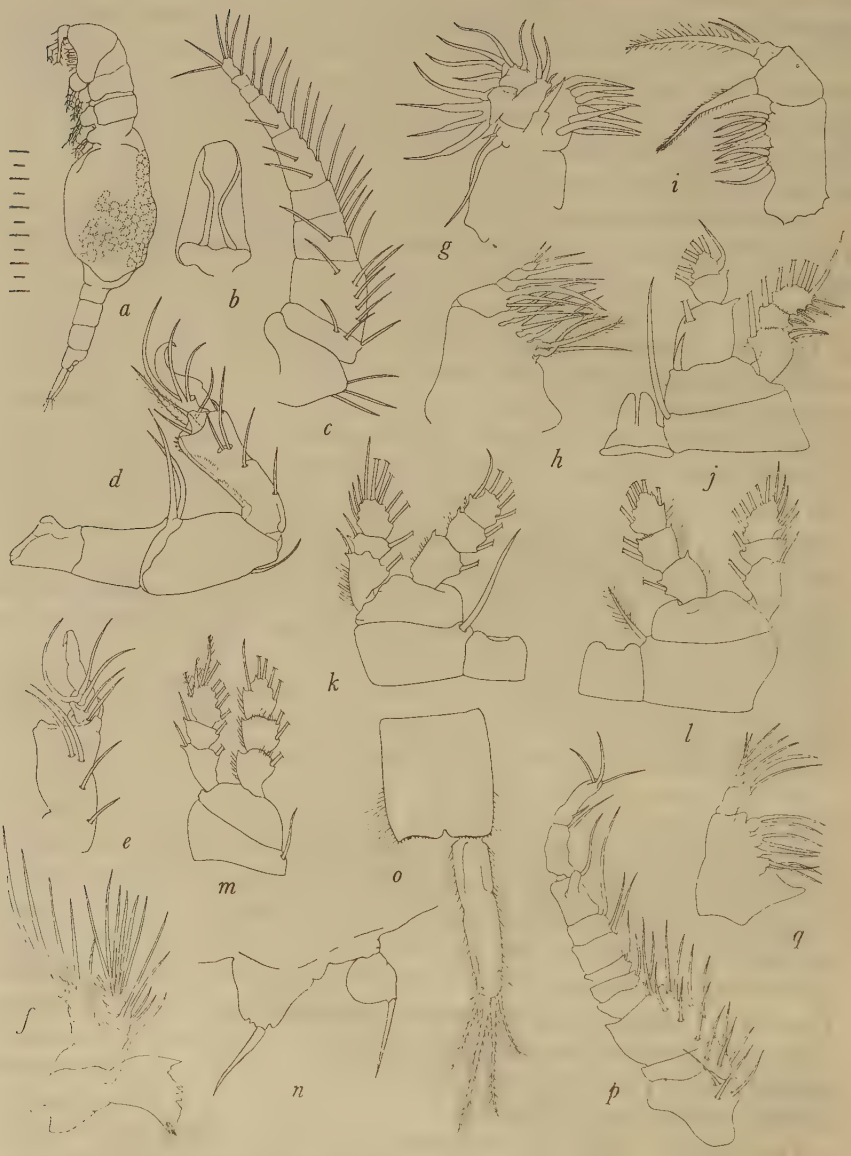


FIGURE 1.—*Notodelphys monoseta* Pearse. *a–o*, Female: *a*, habit, lateral view; *b*, rostrum; *c*, antennule; *d*, antenna; *e*, terminal segment of antenna; *f*, mandible; *g*, maxillule; *h*, maxilla; *i*, maxilliped; *j*, first leg; *k*, second leg; *l*, third leg; *m*, fourth leg; *n*, fifth leg; *o*, caudal ramus. *p*, *q*, Male: *p*, antennule; *q*, maxilla. The scale, referring to *a*, represents 1.0 mm.

About a third of the length of the segment proximal from the apex there are set on the surface a pair of well-developed setae. Slightly posterior to these and closer to the outer margin there is a single seta. Another single seta is inserted on the lateral margin distal about one-third the length of the segment from its articulation. There are two parallel rows of spinules curving over the surface of the segment near its inner margin.

The incisor process of the mandible (fig. 1,*f*) is a medial prolongation of the coxopodite. It is a flat blade, expanded to an elongate serrate margin. At the top distal corner the blade is produced as a stout curved tooth. Below a considerable emargination the masticatory saw consists of three equispaced teeth of similar development; a long, finely serrate bladelike region; and, at the bottom, two slender, seta-like projections.

The basipodite is subquadrate in outline and bears on the medial margin a single well-developed seta. The endopodite consists of two subequal segments. The proximal segment bears a row of four graduated setae, their bases set in a curve around the distal medial margin. The nine setae of the terminal segment are arranged in two groups. Three setae originate on a lateral distal prolongation of the segment. The remainder of the distal margin is occupied by the close-set bases of the six remaining graduated setae.

The exopodite is relatively large, obscurely tetramerous. Four of the five setae are subequal; the apical seta is much enlarged, its length and thickness about double those of the next larger. The insertions of the three proximal setae seem to indicate distal limits of segments. The distal seta is accompanied by a seta placed just subapically and apparently sharing insertion on the terminal segment.

The maxillule (fig. 1,*g*) is characterized by massiveness of the basal portion. The protopodite seems to be 2-segmented. The proximal segment is extended distally as the prominent major endite, this accompanied by a second minor endite, which is represented by a slender setiform structure borne on a prominence. The armature of the proximal endite consists of nine diversified setae, close-set to form a medial masticatory fringe.

An epipodite is represented by a small prominence lateral on the basal segment, from which extends a long stout seta and a reduced auxiliary setule. The orientation of the second segment, which is probably the basipodite, is shifted so that the rami are directed almost laterally and the usually lateral setae are distal. There are two of these, subequal in dimensions. The endopodite is a small, somewhat conical plate ornamented with five setae. One of these is inserted at about the midpoint of the medial margin. The remainder are apical.

The exopodite is a truncated curved structure. The medial margin is strongly convex, the lateral concave. The four large subequal setae are accommodated along the distal margin.

The roughly triangular maxilla (fig. 1,*h*) is pentamerous. The basal segment much exceeds the remainder and bears four variously developed endites. The proximal endite bears three setae apically placed. The second endite is represented by a slight eminence bearing a single seta. The third endite bears two setae. The fourth endite is the largest. It bears two apical setae and a subterminally inserted accessory setule.

The second segment is longer than wide and is produced medially and distally as a very stout, heavily sclerotized hooked spine. Inserted on the base of the spine are two unequal setae.

The third and fourth segments bear each a single distal medial seta. The fifth segment bears two terminal setae, one reduced subapical seta, and a vestige of a setule inserted medially near the base.

The trimerous maxilliped (fig. 1,*i*) is a flattened rectilinear appendage with a setiferous inner margin. The basal segment is slightly more than twice as long as wide. Its nine setae are disposed in two groups. Each group has one seta displaced considerably laterally on the anterior surface of the segment. The remaining trio and quartet of setae are inserted, with close-spaced bases, on the medial margin.

The nearly quadrate second segment is just slightly narrower than the first. Its ornamentation is a single very stout, long, curved seta inserted on the distal medial corner.

The third segment is reduced to little more than a small process articulated on the distal lateral corner of the second segment. It is produced apically as a long stout seta which is disposed in a medially directed curve. Inserted on the base of this principal seta is a minute accessory setule.

Swimming legs: The first legs (fig. 1,*j*) consist of bimerous protopodites and trimerous rami. The coxopodites are yoked together by a heavily sclerotized intercoxal plate. Inserted on the distal medial corner of each coxa is a well-developed seta, thick at the base and finely tapering apically, extending to the tip of the endopodite. The basipodite is characterized by an exceedingly short lateral margin. Inserted near the margin is a reduced lateral seta. The medial distal corner of the basis supports a rather weakly developed spine which reaches to about the midpoint of the basal segment of the endopodite. Each of the two basal segments of the exopodite bears a lateral spine and a medial seta. The terminal segment bears three marginal lateral spines, two apical setae, and three medial marginal setae. The lateral terminal seta is heavily sclerotized at the base, suggesting that it replaces the spine usually inserted at this

side. The two most distal spines and that of the basal segment are rather elongate and taper to slender tips invested in finely serrate marginal flanges. A prominent spinous prominence projects from each of the two basal segments just proximal to the insertion of its spine. The spines of the terminal segment have accompanying prominences of markedly feebler development.

The basal segment of the endopodite much exceeds the combined mass of the distal segments. It bears one seta, inserted somewhat proximal to the distal medial corner. The second segment bears one medial seta. The distal lateral corner of the segment is produced as a short, stout, slightly curved, spinous projection. The terminal segment is nearly right triangular in outline due to the greatly reduced extent of the medial margin and the diagonally directed distal boundary. Across the distal margin is set a row of five close-spaced setae. The proximal four of these are subequal, the apical seta is reduced. At the proximal corner of the medial margin originates a sixth short slight seta.

The second leg (fig. 1,*k*) consists of a bimerous protopodite and trimerous rami. The coxopodites are yoked by a well-developed subquadrate intercoxal plate. Each coxa bears at the medial distal corner a fairly robust seta which extends to about the base of the distal segment of the endopodite. There is a reduced seta inserted near the lateral margin of the basipodite. The two basal segments of the exopodite are markedly contracted proximally and expanded distally. Each bears a lateral spine and a medial seta. Each spine is accompanied by a proximally placed stout spinous projection of the margin of the segment. The terminal podomere is somewhat less constricted basally. Its widest point is at the proximal fourth whence it tapers somewhat to the apex. There are three lateral marginal spines, two apical setae, and four medial setae. All the spines are so slender as to approach setiform dimensions, except for the reduced length.

The segments of the endopodite are somewhat constricted basally. The proximal segment bears one medial seta. The second segment bears two medial setae. The ornamentation of the distal segment consists of three medial setae, two apical setae, and one seta set in an emargination at about the midpoint of the lateral margin. The insertions of the lateral apical seta and the lateral marginal seta and the distal lateral corners of the two proximal segments are ornamented by stout spinous projections of the integument.

The coxopodites of the third legs (fig. 1,*l*) are joined by a well-developed intercoxal plate. At the distal medial corner of each coxa there is inserted a well-developed seta extending to about the middle of the second segment of the endopodite. There is a somewhat

reduced seta inserted near the lateral margin of the basipodite. The two proximal segments of the trimerous exopodite each bear a lateral spine and a medial seta. The ornamentation of the terminal segment consists of three lateral spines, a weak apical spine much modified to present a markedly setiform aspect, except for reduction in length, an apical seta, and four setae inserted on the medial margin.

The armature of three segments of the endopodite consists of one medial seta on the basal segment, two medial setae on the second segment, three medial setae, two apical setae, and one lateral seta on the distal segment.

The fourth leg (fig. 1,*m*) consists of a bimerous protopodite and trimerous rami. The plate yoking the coxopodites is shorter than wide. At the distal medial corner of the coxa is inserted a seta which does not quite reach the distal corner of the somewhat produced medial margin of the basipodite. A seta is inserted near the lateral margin of the basipodite.

The two proximal segments of the exopodite bear each a medial seta and a lateral spine. These spines and those of the distal segment are much reduced, pronouncedly modified in the direction of setiform structure. They are of about the diameter of the most basal seta of the ramus and thus slenderer than the remaining setae. They taper uniformly to extremely fine points, and actually offer no differentiating features from setae on a structural basis. The terminology is here preserved because they occupy the usual points of insertion of spines. The distal segment bears two short lateral spines, a somewhat longer apical spine and an apical seta, and four medial marginal setae.

The proximal segment of the endopodite bears one medial seta. The second segment bears two medial setae. The distal segment bears two medial marginal setae, two apical setae, and one seta on the lateral margin.

Vestigial legs and caudal rami: The bimerous fifth legs (fig. 1,*n*) are much reduced. The basal segment is produced distally at the lateral corner to form a considerable prominence on which is inserted a seta. This setiferous prominence is a stout truncated cone produced almost directly posteriorly. The second segment is small, exceeded considerably by the projection of the basal segment. There is a single short seta borne at the medial distal corner of the terminal segment. The remainder of the distal margin and the lateral margin of this segment form an uninterrupted extent which approaches a semicircular outline.

The caudal rami (fig. 1,*o*) are about five times as long as their greatest width, which is just distal to the constricted base. From the point of greatest width the rami taper slightly to the somewhat

rounded truncate apex. The integument seems to be fairly heavily sclerotized and there is a characteristic ridge of the integument running near to and paralleling the medial margin. The margins of the rami are ciliated. Four setae form a fanlike array across the distal margin of the ramus. The central setae of the quartet are the longest. They are subequal and the length is about seven-eighths that of the ramus. The medialmost and outermost setae are similar, about three-fifths the length of the long setae. On the dorsal surface of the ramus there are inserted two reduced setae. One is just subapical and near the medial margin. The other is on the lateral margin and displaced from the end of the ramus by a distance about equal to the terminal width.

Male (fig. 1,*p–q*): A typical cyclopoid male, 10-segmented with geniculate antennule (fig. 1,*p*). The appendages conform well to those of the female, except that the maxilla (fig. 1,*q*) is somewhat simplified and the swimming legs are more spinose. The usual sixth legs, consisting of setiferous flaps placed over the seminal vesicles, are present.

### *Notodelphys affinis*, new species

FIGURE 2

*Doropygopsis longicauda* Wilson, 1935a, p. 779, (part).

TYPES: Holotypic female, USNM 92816 (type locality, off Iceberg Point, Lopez Island, Washington, from *Ascidia paratropa* (Huntsman)); allotypic male, USNM 92817, same locality and host; paratypes listed below.

SPECIMENS EXAMINED:

WASHINGTON

From *A. paratropa:*

Lopez Island, off Iceberg Point, dredged, 30 meters, July 3, 1939, holotypic female, allotypic male.

Lopez Island, off Upright Head, dredged, 15 fms., July 27, 1949, R. L. Fernald, 22 females.

Off Lopez Island, opposite lower end Fisherman's Bay, dredged, July 13, 1950, 1 female.

East of Upright Channel, dredged, 25–35 fms., June 23, 1950, 2 females.

Upright Channel, dredged, July 25, 1950, R. L. Fernald, 35 specimens.

Near Friday Harbor, dredged, July, 1950, 8 females.

Puget Sound, dredged, Aug. 18, 1949, R. L. Fernald, 10 females.

From *Ascidia callosa* Stimpson:

East of Upright Channel, dredged, 25–35 fms., June 23, 1950, 30 females.

Upright Channel, dredged, July 19, 1950, 3 females.

Off Dinner Island, dredged, 30 fms., Aug. 10, 1949, R. L. Fernald, 5 specimens.

Brown's Island, San Juan Island, intertidal, July 14, 1950, 5 females.

Turn Point, San Juan Island, intertidal, July 16, 1950, 17 specimens.

From *Corella willmeriana* Herdman:
Entrance to West Sound, Orcas Island, dredged, 30 fms., Aug. 10, 1949, R. L. Fernald, 55 females, 2 males, 3 juveniles.
East of Upright Head, Lopez Island, dredged, June 23, 1950, 25 specimens.
President Channel, San Juan Islands, dredged, 105 fms., July 8, 1950, 6 specimens.

CALIFORNIA

From *Phallusia vermiformis* Ritter:
Off Santa Cruz Island, dredged, Feb. 6, 1889, U. S. Fish Comm. Steamer *Albatross*, 1 female.

DESCRIPTION: Female (fig. 2,*a–m*): General features: The body (fig. 2,*a*) is neatly delimited into metasome and urosome. The anterior portion consists of the head, the three free thoracic somites corresponding to the first to third swimming legs, and the expanded brood sack which is a development of the fused somites of the fourth and fifth legs. The articulation of the metasome and urosome falls between the sixth thoracic segment, which bears the fifth legs, and the succeeding seventh thoracic segment.

The urosome (fig. 2,*b*) is slender, subcylindrical, with only a slight taper posteriorly. There are five distinctly demarcated segments. The first is the shortest, and by the presence of the oviducal apertures and the structures connected with the seminal receptacles, it is established as the last thoracic somite. The succeeding four abdominal somites show no significant differentiation in size or proportions.

The front margin of the head is prolonged ventrally as the stout blunt rostrum. This structure is short, about 1½ times as long as its basal width, and tapers uniformly to the rounded apex, which is about half as wide as the base.

Head appendages: The 12-segmented antennule (fig. 2,*c*) is stocky, not reaching to the posterior margin of the head. The taper of the appendage is gradual so that each segment is but slightly narrower than that next proximal. The posture of the antennule is a nearly right-angled flexure which results from the diagonal articulations of the second segment with the first and third. The effect of this arrangement is an approximately triangular outline of the second segment with its outer margin several times longer than the very short inner margin. The other articulations of the antennular segments are transverse to the main axis. The first two segments are much shorter than wide and roughly wedge-shaped. The length of the third segment approaches the sum of the lengths of segments 1 and 2. The fourth segment is roughly rectangular in outline, the length three-fourths the width. The fifth segment is smaller than the preceding, of similar outline. The sixth segment, elongate and markedly tapered, preserves in the sculpturing of the integument evidence of its formation by coalescence of three of the segments usually

occurring at this position in *Notodelphys* species. The succeeding six segments are subequal, short and quadrangular, and taper only very slightly to the apex. The ornamentation of the antennule is an array of numerous setae, mostly plumose, the arrangement of which does not offer any distinctively specific feature.

The antenna (fig. 2,*d*) is distinctive for the unusually developed coalescence of the basic first and second segments of the usual three, so that functionally the appendage is bimerous. The right-angled flexure provides a reference of orientation to the appendage. Indication of the fundamental segmentation is preserved in the diagonal, groove across the segment and the insertion of two long, subequal plumose setae on the inner margin at the point of intersection of the groove. Subterminally on the outer margin is inserted a much shorter, slighter, reduced seta. The distal segment is smaller in extent than the basal unit, both narrower and shorter. Inserted near the lateral margin at intervals equal to about a fourth of the length of that margin are a proximal reduced seta, a second seta at about the midpoint, and a trio of setae at the distal fourth. Forming a complicated insertion on the distal margin of the segment is a stout, tapered, much-curved hook accompanied by four variously developed setae. Fairly heavy spinules form curving lines over the surface of the segment near the inner margin.

The mandible consists of the bimerous protopodite and the usual rami. The medial expansion of the coxopodite (fig. 2*e*) forms a lamella which, along the masticatory margin, is differentiated as four widely-spaced toothlike projections, a short, finely serrate saw-edge, and two small setiform processes. The basipodite is a long segment (fig. 2,*f*) and bears a well-developed seta inserted at the distal third of the inner margin. The proximal segment of the biramous endopodite bears four setae arranged in a row around the distal medial margin. Occupying the distal margin of the second segment are nine setae disposed in two groups of three and six.

The segmentation of the exopodite is suppressed so that the condition is apparently bimerous. One seta is borne on the basal portion, four distally. The setae are graduated in length distally and the terminal seta is the longest with the basal third much expanded as well.

The maxillule (fig. 2,*g*) consists of an obscurely bimerous protopodite and the two monomerous rami. Laterally on the basal portion of the protopodite there is a vestigial epipodite represented by a long stout seta accompanied by a minute accessory setule. Two medial expansions of the basal part of the protopodite represent endites. The more proximal endite is a flaring expansion bearing a row of ten setae disposed along the medial margin. The second endite is repre-

sented by a reduced prominence from which extends a long tapering setiform structure. The endopodite bears five setae, one inserted just subapically on each of the medial and lateral margins and three borne along the distal extremity. The exopodite is widely truncate distally and four large setae are arranged along this margin in a loosely set row.

The major bulk of the pentamerous maxilla (fig. 2,*h*) consists of the basal section. This bears four setiferous medial projections which represent endites. The most proximal projection bears three subequal setae. The ornamentation of the second endite is reduced to a solitary seta. The third endite bears two nearly equal setae. The fourth endite supports two well-developed, equal setae and a reduced setule which is inserted near the base of the more proximal seta. The second segment is about as wide as long in its main mass but is produced medially as a long, stout, falcate process on which the proximal margin is finely denticulate. Inserted basally on this process is an equally long but more slender seta and a much reduced seta. The third and fourth segments each bear a long slender seta inserted at the distal medial corner. The minute fifth segment bears four setae, three subequal ones forming an apical group, with a fourth, much-reduced, inserted proximally on the segment near the medial margin.

The trimerous maxilliped (fig. 2,*i*) is stout and well developed. The basal segment constitutes about two-thirds of the total mass. Its ornamentation consists of nine setae arranged in two groups. The proximal group consists of three setae arranged in close-set formation at about the midpoint of the medial margin. A fourth seta accompanies this group, its insertion displaced considerably laterally to the surface of the segment. Five setae are similarly arranged as a marginal quartet and solitary superficial seta, the group occupying the margin at a level marking the distal quarter of the segment. The mass of the second segment is slightly less than half that of the first. The outline is roughly trapezoidal. Inserted at about the midpoint of the medial margin is the single stout elongate seta. The armature of this member is distinctive, consisting of profuse ciliation basally and marginal denticulation distally. The terminal segment is minute, reduced to little more than a base for the insertion of the three terminal setae. One of these is long and tapered, with plumose ciliation. The accompanying two setae are reduced to very slight proportions.

Swimming legs: The first swimming legs (fig. 2,*j*) consist of bimerous protopodites and trimerous rami. The coxopodites are yoked by a well-developed intercoxal plate of subtriangular outline. Surface sculpturings of the plate convey a characteristic aspect featured by a

FIGURE 2.—*Notodelphys affinis*, new species. *a–m*, Female: *a*, habit, dorsal view; *b*, urosome; *c*, antennule; *d*, antenna; *e*, masticatory lamella of mandible; *f*, palp of mandible; *g*, maxillule; *h*, maxilla; *i*, maxilliped; *j*, first leg; *k*, fourth leg; *l*, fifth leg; *m*, caudal ramus. *n*, Male: antennule. The scale, referring to *a*, represents 1.0 mm.

bilobed distal margin. Inserted on the distal medial corner of each coxopodite is a robust, long, tapered seta, reaching to the distal margin of the second segment of the endopodite. The outline of the basipodite is distinctive. The lateral margin is reduced to a very short distance. Half the width of the segment is terminated by a diagonally directed border. From the midpoint of the distal margin to the distolateral corner the border is roughly squarely transverse to the axis of the limb. The medial margin is two-fifths the width of the segment. Inserted near the short lateral margin is a slender seta. A stout, tapering spine is set at the medial distal corner of the basipodite. The spine extends to the level of the distal third of the basal segment of the endopodite. Each of the two basal segments of the exopodite bears a lateral spine and a medial seta. The terminal segment bears three marginal lateral spines, two apical setae, and three medial marginal setae. The two most distal spines and that of the basal segment are rather elongate and taper to slender tips. They all possess finely serrate marginal flanges. A spinous prominence projects from each of the two basal segments just proximal to the insertion of its spine. The spines of the terminal segment have accompanying prominences of feebler development.

The basal segment of the endopodite much exceeds the combined mass of the distal segments. It bears one seta, inserted somewhat proximal to the distal medial corner. The second segment bears one medial seta. The distal lateral corner of the segment is produced as a short, stout, slightly curved, spinous projection. The terminal segment is nearly triangular in outline with the medial margin and the diagonally directed distal boundary inclining to a narrow apex. Across the distal and medial margins is set a row of five close-spaced setae. The proximal four of these are subequal, the apical seta is reduced. At the proximal corner of the medial margin originates a sixth short slight seta.

The second legs consist of bimerous protopodites and trimerous rami. The coxopodites are yoked by a well-developed intercoxal plate. Each coxa bears at the medial distal corner a fairly robust seta which extends to about the base of the second segment of the endopodite. There is a reduced seta inserted near the lateral margin of the basipodite. The two basal segments of the exopodite are markedly contracted proximally and expanded distally. Each bears a slender, short, lateral spine and a medial seta. Each spine is accompanied by a proximally placed, stout, spinous projection of the margin of the segment. The terminal segment is somewhat less constricted basally. It bears three lateral marginal spines, two apical setae, and four medial setae. All the spines are so slender as to approach setiform dimensions, except for their reduced length.

The segments of the endopodite are constricted basally. The proximal segment bears one medial seta and the second segment bears two medial setae. The ornamentation of the distal segment consists of three medial setae, two apical setae, and one seta set at about the midpoint of the lateral margin. The insertions of the lateral apical seta and the lateral marginal seta and the distal lateral corners of the two proximal segments are ornamented by stout spinous projections of the integument.

The coxopodites of the third legs are joined by a well-developed intercoxal plate. At the distal medial corner of each coxa there is inserted a well-developed seta extending to about the base of the second segment of the endopodite. There is a reduced seta inserted near the lateral margin of the basipodite. The two proximal segments of the trimerous exopodite each bear a short, slender, lateral spine and a medial seta. The ornamentation of the terminal segment consists of three lateral spines, a weak apical spine much modified to present a markedly setiform aspect, an apical seta, and four setae inserted on the medial margin.

The armature of the three segments of the endopodite consists of one medial seta on the basal segment, two medial setae on the second segment, and three medial setae, two apical setae, and one lateral seta on the distal segment.

The fourth legs (fig. 2,*k*) consist of bimerous protopodites and trimerous rami. The intercoxal plate is much shorter than wide. At the distal medial corner of the coxa is inserted a seta which extends to about the midpoint of the first segment of the endopodite. A minute seta is inserted near the lateral margin of the basipodite.

The two proximal segments of the exopodite bear each a medial seta and a lateral spine. These spines and those of the distal segment are much reduced, pronouncedly modified in the direction of setiform structure. They taper uniformly to extremely fine points, and offer no differentiating features from setae on a structural basis. The distal segment bears two such short lateral spines, a somewhat longer apical spine and an apical seta, and four medial marginal setae.

The proximal segment of the endopodite bears one medial seta. The second segment bears two medial setae. The distal segment bears two medial marginal setae, two apical setae, and one seta on the lateral margin.

Vestigial legs and caudal rami: The bimerous fifth legs (fig. 2,*l*) are much reduced. The basal segment is produced distally at the lateral corner to form a considerable rectangular prominence on which is inserted a seta. The short, bluntly conical second segment is small, exceeded considerably by the projection of the basal segment.

There is a single short seta borne at the medial distal corner of the terminal segment.

The caudal rami are about five times as long as their basal width. They taper slightly to the somewhat rounded truncate apex. The margins are heavily ciliated. Four setae form a fanlike array across the distal margin of the ramus. The central setae of the quartet are the longest. They are subequal and their length slightly exceeds that of the ramus. The medial and outermost setae are subequal, about half the length of the long setae. On the dorsal surface of the ramus there are inserted two reduced setae. One is just subapical, near the medial margin. The other is on the lateral margin and displaced from the end of the ramus by a distance slightly exceeding the terminal width.

Male (fig. 2,*n*): The male is of the generalized notodelphyid type. The antennules (fig. 2,*n*) are modified as clasping structures. Otherwise the appendages conform well to those in the female, except for the presence of the small sixth legs absent in the female.

Remarks: In life this species is distinctively colored, with the body flesh to orange-brown and the egg masses dark green. In the transparent bodies of their hosts, some of these copepods may be detectable by superficial examination. The usual infestations are in considerable numbers, usually including juveniles as well as adults. A marked tolerance of the situation of the host is indicated, as specimens have been taken from tunicates ranging from intertidal occurrence to a collection obtained by dredging in 105 fathoms.

### Indeterminable Species

#### *Notodelphys ascidicola* Allman

*Notodelphys ascidicola* Allman, 1847a, pp. 2–6, pl. 1, figs. 1–14, pl. 2, figs. 16–20, 22 (part, not figs. 12, 15, 21) (type locality, British Isles, in *Ascidia communis*); 1847, p. 74.—Baird, 1850, pp. 238–239.—Thorell, 1859a, pp. 5, 6, 46, 59; 1859b, pp. 336–337; 1860, pp. 114, 115, 116.—Claus, 1860, pp. 229–233, pl. 6, figs. 1–8.—van Beneden, 1861, p. 146.—Gerstaecker, 1863, p. 404.—Norman, 1869, p. 299.—Gerstaecker, 1870–1871, pp. 776, 801.—Hartmeyer, 1911, p. 1735.—Schellenberg, 1922, p. 227.

#### *Notodelphys antarctica* Brady

*Notodelphys antarctica* Brady, 1910, p. 568, figs. 1–8, text fig. 55 (type locality, Gauss-Station).—Schellenberg, 1922, p. 227.—Sewell, 1949, pp. 154, 174.

#### *Notodelphys matronalis* Leigh-Sharpe

*Notodelphys matronalis* Leigh-Sharpe, 1934, pp. 4–6, figs. 1, 2 (type localities, Salomakië, Gebé Island, in *Ascidia rhabdophora* Sluiter, *Styela asymmetrica* Sluiter).—Lang, 1949, p. 6—Sewell, 1949, p. 163.

## Genus *Notodelphyopsis* Schellenberg

*Notodelphyopsis* Schellenberg, 1922, p. 237 (type species, by monotypy, *N. falciferus* Schellenberg, 1922).—Gurney, 1927, p. 481.—Wilson, 1932, p. 599.—Sewell, 1949, p. 174.
*Notodelphys* Lang, 1948, p. 5 (part).

The collection of a compressed notodelphyid exhibiting many of the characters of the genus *Notodelphys* in the features of the appendages brought forth a problem in generic assignment. The correspondence to the genera *Paranotodelphys* and *Notodelphyopsis* of Schellenberg was so close that it was concluded that, despite its habitus, it must be classified near these depressed examples of the group. The obtaining of a specimen which showed close correspondence to *Notodelphyopsis falciferus* Schellenberg, except for very minor details, has made possible a closer comparison and it is felt a satisfactory grouping can be made. The profoundest difference between *Paranotodelphys* and *Notodelphyopsis* is in urosomal segmentation. In *Paranotodelphys* there are five segments, with no fusion of thoracic and abdominal elements. In *Notodelphyopsis* there are four urosomal segments, the first of which is a genital complex, probably formed by fusion of the most posterior thoracic and most anterior abdominal somites.

Description: The body habit is variable, in the known forms ranging from compression to depression, with secondary inflation. The antennule may be of generalized type and 9-segmented, or highly modified and 7-segmented. The antenna is a modified trimerous structure, closely corresponding to that found in *Notodelphys*, with the same ornamentation of two plumose setae borne on the basal segment, and other conformity of details. The mandible is much like that of *Notodelphys*, with no important difference in the masticatory lamella, and with similar arrangement and setation of the palp. In the maxillule the exopodite bears four setae, the endopodite may have five or six setae. The maxilla is of generalized type. The second segment bears a conspicuously developed falcate hook-process. The maxilliped is trimerous, with only the first and third segments setiferous. The distal segment bears two or three subequal plumose setae. This appendage is distinctive in this character. The swimming legs are only specifically modified, with some elaborate specializations, but the basic pattern is generalized. The fifth legs are weakly developed bimerous appendages, much like those in *Notodelphys*, or they may be lacking.

The male is known only for the new species proposed below, so the range of generic variation can not be established.

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## Key to the species of *Notodelphyopsis*

1*a*. Body depressed, antennule 7-segmented, fifth legs absent.
**falciferus** (p. 512)

1*b*. Body compressed, antennule 9-segmented, fifth legs present.
**perplexa** (p. 512)

### Species not known from North America

### *Notodelphyopsis falciferus* Schellenberg

*Notodelphyopsis falciferus* Schellenberg, 1922, pp. 237–239, figs. 17–20 (type locality, Sharks Bay, Australia, in *Ascidia gemmata* Sluit.).

Distribution: Australia.

Host: *Ascidia gemmata* Sluit.

### North American Species

### *Notodelphyopsis perplexa*, new species

Figure 3

Types: Holotypic female, USNM 92810 (type locality, off San Nicolas Island, Calif., from *Ascidia clementea* Ritter); allotypic male, USNM 92811, and paratypes from the same lot of specimens.

Specimens examined:

California

From *A. clementea:*

Off San Nicolas Island, Apr. 13, 1904, dredged, 1,084–1,110 fms., U. S. Fish Comm. Steamer *Albatross*, holotypic female, allotypic male, 12 female and 6 male paratypes.

Description: Female (fig. 3,*a–p*): General features: The markedly compressed body (fig. 3,*a*) is 9-segmented. The metasome consists of a head-segment bearing antennules, antennae, mouthparts and maxillipeds, three somites bearing the first three swimming legs, and an incubatory segment bearing fourth and fifth swimming legs.

Articulated on this metasome is a 4-segmented urosome, including no pedigerous somite. The proximal segment is a genital segment, of marked cyclopoid aspect, almost as long as the combined remaining segments. There are three subequal posterior segments, including the telson. The caudal rami are one and a third times as long as the anal segment.

The rostrum is narrow and elongate, tapering in the distal third to form a fairly acute apex.

Head appendages: The antennule (fig. 3,*b*) is 9-segmented, although there remain indications of subdivision of segments 3 and 4. The posture of the antennule is characteristic, forming a distinct angle of almost 90°. This is due to actual curvature of the second segment to form an elbow bend. With accompanying slightly diagonal articulations of the first and third segments on the second, the near-

right-angled flexure is achieved. The two basal segments are the greatest in diameter and exhibit a slight taper distally. The succeeding three segments diminish in diameter distally in telescope fashion. The terminal three segments are aligned with a very slight uniform taper.

The lengths of the proximal six segments are nearly subequal, the tapered diameters furnishing the considerable differentiation of the proportions. The first segment is wider than long, the second just slightly longer than wide. The sixth segment is nearly three times as long as wide. The distal segments are nearly equally long and, in each, the width is just slightly exceeded by the length.

The setation of the antennule is profuse. The setae are slender and in the present specimen fall into graceful curves and spirals. The outer margin of curvature of the appendage is the setiferous margin.

The antenna (fig. 3,*c*) is trimerous. The distal segment is the longest and is articulated by a very mobile elbow joint with the basal portion which forms an apparently firmy integrated member with a diagonal articulation which approaches actual fusion. The basal joint is longer than the second. The distal extremity of the first joint lies on the inside of the right-angled flexure in which the limb apparently normally falls. At this distal point originate two long, equal, profusely plumose setae. The second segment tapers somewhat to the elbow joint. The inner margin is convexly expanded. The outer margin is nearly linear to a level at about the distal third of its extent where there is a slight emargination. Here is set a short slender seta.

The margins of the distal segment are sinuate and only roughly parallel, although in the main the aspect of the segment is linear. The terminal articulated hook is curved and slender. It is accompanied by a number of subequal setae inserted in a longitudinal row. There are two small setae borne on the end of the segment also. Midway on the segment there are borne two setae, mainly closely appressed to the surface of the segment. At the proximal quarter of the outer margin is inserted a short slender seta. The distal inner margin of the segment bears a row of spinules which continues diagonally over the surface of the segment.

The mandibles consist of a short coxal segment produced medially as a toothed masticatory plate (fig. 3,*d*) and an expanded basis supporting the two rami (fig. 3,*e*). The armature of the basis is a single seta inserted at about the distal third of the medial margin. The endopodite is basically 2-segmented, although the proximal line of articulation is approaching obsolescenece. The distal medial corner of the proximal segment bears three setae. The apical segment is

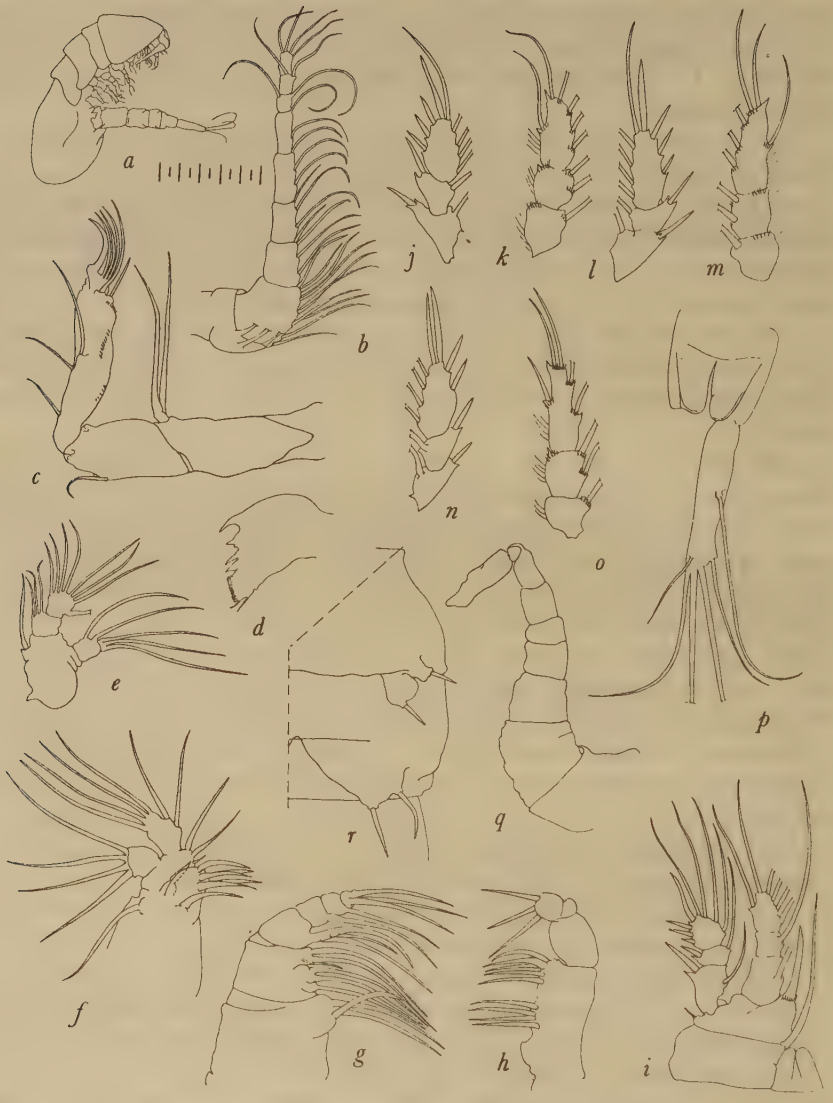


FIGURE 3.—*Notodelphyopsis perplexa*, new species. *a–p*, Female: *a*, habit, lateral view; *b*, antennule; *c*, antenna; *d*, masticatory lamella of mandible; *e*, palp of mandible; *f*, maxillule; *g*, maxilla; *h*, maxilliped; *i*, first leg; *j*, exopodite of second leg; *k*, endopodite of second leg; *l*, exopodite of third leg; *m*, endopodite of third leg; *n*, exopodite of fourth leg; *o*, endopodite of fourth leg, *p*, caudal ramus. *q–r*, Male: *q*, antennule; *r*, somites of fifth and sixth legs, left side. The scale, referring to *a*, represents 0.5 mm.

about as broad as wide and exhibits a slight distal flare. The armature consists of nine setae arranged around the distal half of the segment.

The exopodite is monomerous with the appearance of a short truncated cone. Three long setae orginate, with very closely spaced bases, on the apex. Two additional setae are spaced at subequal intervals along the medial (or distal) margin.

The maxillule (fig. *3,f*) consists of an obscurely segmented protopodite and two well-developed rami. The proximal portion of the protopodite bears medially an expanded setiferous endite. The seven setae comprise a very close-set group of six at the distal medial margin of the endite and a single seta considerably removed proximally and laterally from the group. There is a weakly developed seta-like medial member which seems to be a second endite. The epipodite is represented by a long seta. The terminal portion of the protopodite, probably basis, bears three markedly subequal setae on the medial margin.

The endopodite is rather narrower than long and is ornamented with six setae. Four are set in a row along the whole of the somewhat diagonally truncate distal margin. A fifth is slightly subterminal and the sixth is inserted at about the midpoint of the medial margin.

The four large, nearly equal setae of the exopodite are set in a close-spaced row along the distal margin of the single segment.

The maxilla (fig. *3,g*) is pentamerous with indications of subdivision of the protopodite. The medial margin of the protopodite is produced as four variously developed endites. The most proximal endite is a fairly conspicuous conical protuberance supporting three apically inserted setae. The second endite is represented by a single, nearly sessile seta. The third endite is less reduced; its ornamentation comprises two equal setae. The fourth endite is a rectangular process slightly longer than wide. Apically it supports two equal setae. There is a reduced accessory setule inserted just proximal to the insertion of the more basal seta.

The second segment is produced medially into a heavily sclerotized falcate spine. Basally this exceeds any of the setae of the appendage but the distal three-fourths are as slender as the accompanying setae. The length of the spine is about an eighth less than that of the longest setae of the appendage. The tip of the spine is a clearly defined sclerotized point. Accompanying this spinous process is one long, very well-developed seta and a considerably slighter seta. The latter is about an eighth shorter than the spine and its thickness is about a fourth that of the major seta.

The succeeding two segments are wider than long and each bears a medial distal seta. The terminal segment bears three setae apically inserted with their bases very close together.

The maxilliped (fig. 3,*h*) is distinctly trimerous. The ornamentation of the basal segment is arranged as two groups of members. Each group is comprised of setae and of one stout, tapered spine. The proximal group is three setae and a spine. The distal group consists of four setae and a spine. The second segment is a relatively large one, its width about two-thirds that of the basal segment. The length is about one-third again as great as the width. There is no seta or spine borne on this segment. The inner margin bears a fringe of fine ciliation.

The terminal segment is small, of about one-third the extent of the second. The ornamentation consists of three terminally placed subequal setae.

Swimming legs: The protopodites of the first swimming legs (fig. 3,*i*) are connected by a well-developed intercoxal plate. Each coxa bears at the distal medial corner a long seta which extends about to the tip of the endopodite. The basipodite is roughly right-triangular, the hypotenuse represented by the distal margin. On this is set at a medial apex a long, stout spine, and the remainder of the extent mainly consists of the articulations of the rami. The spine reaches to just short of the midpoint of the terminal segment of the endopodite. There is a reduced seta borne just medial to the short lateral margin of the basis.

The three segments of the exopodite are more equivalent in size than those of the endopodite. The proximal segment is largest, the second is smallest. There are a lateral spine and medial seta borne on each of the two more proximal segments. The terminal segment bears three lateral marginal spines, a terminal spine and seta, and three medial marginal setae. The spine of the basal segment is the stoutest spine and its length about equals that of the apical spine. The shortest spine is that placed most proximally on the distal segment.

The trimerous endopodite is armed only with setae: one on the basal segment, one on the second segment, six on the terminal segment. Of these six, four are lateral, one is apical, and one is inserted in an emargination of the lateral margin which is at about the distal third of the length of that margin. The basal segment of the endopodite is produced so that its extent nearly equals that of the two remaining segments combined.

A well-developed intercoxal plate connects the protopodites of the second swimming legs. There is a well-developed seta at the distal medial corner of the coxa. There is a reduced, fine seta borne laterally on the basipodite. The rami are both trimerous, of roughly equal segments.

The two proximal segments of the exopodite (fig. 3,*j*) bear each a

lateral spine and a medial seta. The terminal segment has three marginal lateral spines, a terminal spine and seta, and four setae arranged along the medial margin.

The proximal segment of the endopodite (fig. 3,*k*) bears a single medial seta, the second segment two medial setae. Four setae are arranged along the medial margin of the terminal segment; one seta is apical; and one seta is set in an emargination slightly distal to the midpoint of the lateral margin of the segment.

The protopodite of the third leg consists of two subequal segments, basipodite and coxopodite. The coxae are yoked by the well-developed intercoxal plate. A seta of slighter dimensions than those of the rami is inserted at the distal medial corner of each coxa. There is a reduced seta inserted near the lateral margin on the basipodite.

The exopodite (fig. 3,*l*) is trimerous. The proximal two segments each bear a lateral spine and medial seta. The terminal segment bears three lateral marginal spines, a terminal spine and seta, and four setae arranged along the medial margin.

The proximal segment of the trimerous endopodite (fig. 3,*m*) bears a single medial seta. The second segment bears two medial setae. The distal segment bears four setae arranged along the medial margin, an apical seta and one seta inserted in an emargination somewhat distal to the midpoint of the lateral margin.

The coxopodites of the fourth legs are yoked by an intercoxal plate. At the distal medial corner of each coxa is inserted a seta which extends just beyond the midpoint of the second segment of the endopodite. There is a reduced seta inserted near the lateral margin of the basipodite.

The proximal two segments of the trimerous exopodite (fig. 3,*n*) each bear a lateral spine and medial seta. The terminal segment bears two spines on the lateral margin, an apical spine and seta, and four medial marginal setae.

The endopodite (fig. 3,*o*) is trimerous. The basal segment bears one medial seta. The second segment bears two medial setae. The distal segment bears five setae, two on the medial margin, two apical, one inserted in an emargination somewhat distal to the midpoint of the lateral margin.

Vestigial legs and caudal rami: The bimerous fifth legs are very reduced. The basal segment is much produced at the lateral distal corner to form a prominence bearing a single seta. The small, somewhat conical second segment bears a single apical seta.

Each caudal ramus (fig. 3,*p*) is five times as long as its greatest width and the ornamentation consists of six well-developed setae. Three setae are apical; the innermost slightly exceeds the segment in length, the more lateral two are very long and apparently pliable.

Somewhat subapically near the medial margin on the dorsal surface is inserted a short, slender seta. At about the same longitudinal level is set a distolateral seta, as stout as the inner apical seta and about as long as the ramus. Just proximal to the midpoint of each lateral margin, and clearly set on the dorsal surface, is an unusually well-developed seta, in length slightly exceeding that of the ramus. All the setae are plumose. The margins of the ramus are not ciliated.

Male (fig. 3,*q–r*): In this species the male is of the generalized cyclopoid type. The size is much smaller than in the female due to the lack of inflation related to the brood sack. The antennule (fig. 3,*q*) is geniculate with a coalescence of the terminal segments to participate in a movable hinge. Some of the more basal segments also are partially or entirely fused. The appendages otherwise conform well to the female pattern.

The urosome is 6-segmented, a marked contrast to the tetramerous condition in the female. Here, further, the articulation of the urosome is between the somites of the fourth and fifth legs. The somites of the fifth and sixth legs are considerably fused into a distinctive compound structure (fig. 3,*r*). On the anterior portion of this region are borne the bimerous fifth legs. The proximal segment of the fifth leg is much reduced but exhibits a lateral rectangular protrusion. Apically on this process a short seta is inserted. The second segment is flattened with an expanded outline. The medial margin is nearly straight, the lateral edge is almost a semicircle. At the apex is set a short slender seta.

The sixth legs are simple protrusions on the flaps covering the genital orifices. Each consists of two slight projections bearing subequal short setae.

NOMEN NUDUM

*Notodelphyopsis variabilis* Sewell, 1949, p. 174.

### Genus *Doropygus* Thorell, emended

*Doropygus* Thorell, 1859a, pp. 43–46 (part; type species, by later designation, G. Sars, 1921, *D. pulex* Thorell, 1859a).—Claus, 1875, p. 350 (part); 1880, p. 553 (part).—Giesbrecht, 1882a, pp. 324–326 (part).—Calman, 1909, p. 103 (part).—G. Sars, 1921, p. 42 (part).—Schellenberg, 1922, pp. 238–241 (part).—Brehm, 1927, p. 490 (part).

DESCRIPTION AND DISCUSSION OF TAXONOMIC CHARACTERS: The body form in the main is little modified, varying from a compact habit tending to be somewhat globose to an opposite considerable elongation. The metasome is 5-segmented, consisting of the head, three relatively unmodified thoracic somites, and the enlarged segment containing the brood sack. All the known representatives are more or less compressed. The urosome is basically 6-segmented, composed

of two thoracic somites, including that of the fifth legs, and four free abdominal segments. The caudal rami are relatively simple, with reduced ornamentation. The rostrum is well developed.

The antennule is typically 9-segmented, with moderate to reduced ornamentation. The antenna is trimerous, usually with very sparsely developed setation.

The mandible is of very generalized type with no great tendency to specialization. The maxillule is moderately developed. The setation of the rami consists of few members. The maxilla is typically pentamerous and not markedly modified. The armature of the second segment varies from the prominent hook process of many notodelphyids to unaltered setae. The maxilliped is reduced, basically bimerous, the segmentation tending to obsolescence. The terminal segment bears two setae.

The swimming legs are typically of generalized type with a few trends toward specialization. The armature tends to become uniformly setiform in many species. The segmentation of the posterior endopodites is reduced from the trimerous to the bimerous condition in a large series of examples. The fifth legs are robust, bimerous appendages, with feebly developed armature.

Sexual dimorphism seems to occur in a transitional state in the genus *Doropygus*. In the species *D. mohri* a similarity to the considerable disparity of the sexes in *Doropygopsis* is seen. In the male, the antennule preserves traces of prehensile adaptation, as seen in the coalescence of terminal segments. The ornamentation and segmentation of the swimming legs are most unlike in the two sexes. There is even a dimorphism in the almost vestigial fifth legs. In *D. bayeri* the opposite extreme is seen. Here there is practically no expression of dimorphism in appendages except in very minor and refined details of ornamentation.

Among the representatives of *Doropygus* here studied two antithetical trends of specific differentiation were encountered. One of these has already been noted in the literature. Schellenberg (1922), in his examination of ascidicoles from all over the world, compiled an extended list of occurrences of *D. pulex* from many localities and from a long roster of hosts. He pointed out that many of these examples exhibited minor distinctive characteristics, but he did not consider the anatomical differentiation sufficient to warrant specific designation. Lang (1948) was of the opinion that Schellenberg's list was in reality a compilation of several distinct species. It seems indisputable, however, that the question will have to remain open until the influence of ecological factors upon the structures of these copepods can be appraised. Existence as commensals in different hosts can very well represent existence in extremely disparate milieus. It would be most

probable, accordingly, to encounter ecotypes in the population of an extremely eurytopic species.

A parallel instance was experienced in the present study of *D. laticornis*. Specimens were obtained over a geographic extent ranging from Massachusetts to the Gulf Coast of Florida and a very diverse array of hosts was represented. Almost every lot of copepods presented distinctive features, yet, in the aggregate, the picture seemed to resolve as an instance of random variation of a number of plastic characteristics. The extremes of structural differentiation were encountered at the geographic extremes of this distribution. However, additional host records and intervening localities provided transitional examples which made it seem unnecessary to attempt taxonomic distinctions among the assemblage. This problem, too, will await further details of ecological knowledge of the group.

A contrary tendency was in evidence in the distribution of species in western North America. An extensive series of ascidians was assembled and each of several species was accompanied by a specifically differentiated *Doropygus*. The existence of the case stated above leads to slight suspicion as to the taxonomic validity of the Western species. Here again the ecotypic problem remains to be examined. However, these forms all stand well apart in terms of the familiar criteria of specific distinction and their distribution over a generous sampling has remained constant.

The interest of the possibilities of operation of ecological factors in this pattern among the Western American species of *Doropygus* is enormously heightened by the parallel distribution of representatives of the genus *Pygodelphys* among the identical ascidian hosts. In this case the structural differentiation has been considered here as below the level of specific significance. Hence a single species is recognized as occurring in eurytopic distribution in association with nine or more host species.

*Doropygus* in Schellenberg's sense was obviously too inclusive. However, it is extremely difficult to subdivide the genus. A group of three of Schellenberg's species is separable with the excellent key character of the reduced fifth legs, which in their rudimentary construction, still retain an aspect strongly reminiscent of the structure in *Notodelphys*. The antennal ornamentation is consistent in these species and furnishes a second strongly differentiating character. Accordingly, *Doropygus lamellipes*, *D. antarcticus*, and *D. novae seelandius* of Schellenberg should be removed to this genus, *Pygodelphys*. The state of the antennule, antenna, and the fifth leg in *Pygodelphys* would seem to indicate derivation from the notodelphyid stock prior to derivation of the remainder of the species assigned to *Doropygus*.

A further difficulty in assigning Schellenberg's species is allocation of his *D. cylindriformis*. From the description, this form cannot be accommodated in any known genus without alteration of the generic concept, and this step is inadvisable in the absence of specimens for study. Gurney (1927) considered *D. cylindriformis* very possibly referable to *Pseudonotodelphys*. Obstacles to this inclusion would be that there is a much more reduced antenna and a less reduced mandibular exopodite in *D. cylindriformis*, with a maxilliped that would seem derivable from a more primitive condition than that in *Pseudonotodelphys*. I do not consider the compression of *D. cylindriformis* significant. The reduction to absence of fifth legs and the configuration of legs 1 to 4 are very readily derivable from the basic *Notodelphys* type. I would consider the species as best accommodated in the *Notodelphys* complex and probably deserving of generic rank. More specimens are needed for detailed study to permit final settlement of the situation, and, until further descriptive details and illustrations of the anatomical features become available, the form is here considered as a species incerta sedis.

Sars anticipated Schellenberg in recognizing the advisability of subdividing *Doropygus*. The assemblage remaining after exclusion of the *Pygodelphys* species and *D. cylindriformis* is sufficiently diverse that it is susceptible to further logical partition. The complex of species closely allied to *D. pulex* seems to form a fairly coherent group. Basic similarity in a corresponding degree of reduction of appendages would group together a series with a notably significant key character in the armature of the maxillular rami. The basic condition of four exopodite setae and three endopodite setae can be demonstrated in *D. trisetosus* and *D. spiniferus* and the process of modification is seen in the transitional phase in *D. demissus*, in the concept here adopted, where the exopodite setal number varies from four to three. A considerable series, Arctic and American, is characterized by three setae on each ramus: *D. demissus*, in the typical form, *D. laticornis*, *D. curvatus*, and the various new Western American species. In the inverse direction of modification, *D. pulex* and *D. longimatrix* exhibit the basic four exopodite setae, with reduction of the endopodite complement to two.

The maxilliped structure is consistent throughout the whole series. The mandibular palp shows graduation from an exopodite with five setae to one with four. This group of species, since it contains *D. pulex*, the type, will constitute *Doropygus*, sensu stricto. The subdivision was anticipated by Schellenberg in his proposition of a "pulex-group" (as contrasted to a "longicauda-group") for the species he considered. Unfortunately, he selected a character which does not seem to exhibit fundamental phylogenetic significance for differenti-

ating his groups. As a result, *D. longimatrix*, which has very profound affinities with *D. pulex*, was placed in the "longicauda-group" because of the relatively insignificant fact (in my opinion) that the terminal abdominal somite does not bear the caudal rami on divergent prolongations, which condition would give the usual effect, as in *D. pulex*, of a cleft anal segment.

The species remaining after exclusion of *Doropygus*, sensu stricto, present difficulty in definition as natural groups. One line of evidence uniting the species is the consistent presence in all of the basic four setae of the maxillular exopodite. In all, as well, the number of endopodite setae is variable but progresses upward from a basic count of at least six. Since in some a distinct 2-segmented condition of the endopodite is present, the appendage in such a representative as *D. longicauda* exhibits the most primitive condition found among the notodelphyids, seemingly presenting a more basic arrangement than occurs in *Notodelphys*. (In *D. longicauda* the maxilliped is also more primitive than in *Notodelphys* in preserving a more basic number, four, of setae on the terminal segment. *Pachypygus* corresponds to *D. longicauda* in both these features. Both *Pachypygus* and *Doropygopsis*, however, possess more reduced or otherwise phylogenetically advanced features in the antennules, antennae, and mandibles over the condition in *Notodelphys*.)

All of the *Doropygus* series, excluding the species of *Pygodelphys*, probably could not be derived directly through *D. longicauda* as a stem, since in most species of *Doropygus*, sensu stricto, the mandibular exopodite retains a more primitive condition than that found in *D. longicauda*. The mandibular exopodite in *D. longicauda* is an unsegmented plate (as in *Pachypygus* and other genera). Various species of *Doropygus* preserve the segmented aspect of this ramus to varying degrees, a condition I would regard as more primitive. An antecedent form of *D. longicauda* would have had to furnish the common ancestor of *Doropygus*, sensu stricto, and the present *Doropygopsis* assemblage. On this basis, *D. longicauda* represents one of the specialized species now existent in its group. A number of species are more primitive on the basis of segmentation of the mandibular exopod, but are consistent with *D. longicauda* on the basis of setation of the maxillule, and, further, furnish graduated series either with reference to ornamentation of the antenna or in arrangement of the maxilliped.

*D. thorelli* and *D. novemsetiferus* are very closely allied with *D. longicauda* with reference to maxilliped structure. *D. novemsetiferus* is probably the species most closely allied with *D. longicauda*. *D. thorelli* shows a trend to suppression of the middle joint of the maxilliped in an early stage. The segment is there, but without ornamenta-

tion. In *D. porcicauda* and *D. psyllus* the middle segment is suppressed, but the terminal setal complement of three, as in *D. thorelli*, is preserved. In *D. normani*, which in most features closely resembles *D. psyllus*, reduction to two terminal setae produces a maxilliped anatomically identical with that in *Doropygus*, sensu stricto. This could justifiably be held to be a perfect example of convergence, and I can think of no logical argument against constructing the series as here presented, if the descriptive details available for *D. normani* are correct. Unfortunately, the original description is not sufficiently detailed, nor the illustrations sufficiently refined to satisfy modern demands in critical comparison of anatomical features, and specimens were not available for verification in the present study.

However, a second most significant bit of evidence almost clinches the convergence theory. In *Doropygus*, sensu stricto, the urosome is a primitive one, like that of *Notodelphys* in including four free anatomically abdominal segments. Further, the thoracic segment of the fifth legs is free of the incubatorium in *Doropygus*; thus a 6-segmented urosome is present, with every anatomical segment distinct.

In *Doropygopsis* and in the *thorelli-normani* line there is a cyclopoid "genital-segment" consisting of the fused last thoracic and first abdominal segments, so that here the urosome is 5-segmented, although still including the somite of the fifth leg. *D. normani* seemingly conforms in this anatomical feature.

If Sars' generic subdivision is to be adhered to, *Doropygopsis* will accommodate the species *D. longicauda* and *D. novemsetiferus*. *Doropygella* would then include *D. thorelli*, *D. psyllus*, *D. normani*, and *D. porcicauda*.

### Key to the species of *Doropygus*, based upon females

1*a*. Second segment of maxilla with stout, well-developed hook. . . . . 2
1*b*. Second segment of maxilla with only setiform elements. . . . . 4

2*a*. Mandibular exopodite with 4 setae . . . . . **seclusus** (p. 579)
2*b*. Mandibular exopodite with 5 setae. . . . . 3

3*a*. Distal segment of maxilliped distinct, well developed . . **demissus** (p. 537)
3*b*. Distal segment of maxilliped much reduced. . . . . **mohri** (p. 562)

4*a*. Maxillular exopodite with 4 setae . . . . . 5
4*b*. Maxillular exopodite with 3 or fewer setae . . . . . 9

5*a*. Maxillular endopodite with 2 setae. . . . . 6
5*b*. Maxillular endopodite with 3 setae. . . . . 7

6*a*. Mandibular exopodite with 5 subequal, well-developed setae. **longimatrix** (p. 524)
6*b*. Mandibular exopodite with 4 setae, or with a fifth much reduced. **pulex** (p. 525)

7*a*. Lateral armature of exopodites 2 to 4 spines . . . . . **spiniferus** (p. 524)
7*b*. Lateral armature of exopodites 2 to 4 setae . . . . . 8

8*a*. Mandibular exopodite with 4 setae . . . . . **trisetosus** (p. 524)
8*b*. Mandibular exopodite with 5 setae, 1 reduced. . . . **kerguelensis** (p. 524)
9*a*. Endopodites 2 to 4 trimerous. . . . . **curvatus** (p. 524)
9*b*. Endopodites 2 to 4 bimerous . . . . . 10
10*a*. Maxillular exopodite with 2 setae. . . . . **schellenbergi** (p. 574)
10*b*. Maxillular exopodite with 3 setae . . . . . 11
11*a*. Basal segment of third exopodite lacking medial seta. . . . **bayeri** (p. 544)
11*b*. Basal segment of third exopodite bearing medial seta. . . . . 12
12*a*. Basal segment of antenna lacking ornamentation. . . . . **hummi** (p. 557)
12*b*. Basal segment of antenna bearing 2 subterminally inserted setae . . . . 13
13*a*. Basal segment of fourth exopodite with medial seta . . . **laticornis** (p. 530)
13*b*. Basal segment of fourth exopodite lacking medial seta . . . . . 14
14*a*. Caudal rami lacking apical setae. . . . . **fernaldi** (p. 551)
14*b*. Caudal rami set with 4 apical setae . . . . . **profundus** (p. 569)

## Species not known from North America

### *Doropygus longimatrix* Schellenberg

*Doropygus longimatrix* Schellenberg, 1922, pp. 245–246, figs. 24, 25 (type locality, Gulf of Suez, in *Pyura momus* Sav.).—Gurney, 1927, p. 480.—Sewell, 1949, pp. 169, 179.

Distribution: Gulf of Suez.

Host: *Pyura momus* Sav.

### *Doropygus spiniferus* Schellenberg

*Doropygus spiniferus* Schellenberg, 1922, pp. 248–249, 265 (type locality, southwestern Australia, in *Molgula nodosa* Hartmr.).—Sewell, 1949, p. 174.

Distribution: Southwestern Australia.

Host: *Molgula nodosa* Hartmr.

### *Doropygus trisetosus* Schellenberg

*Doropygus trisetosus* Schellenberg, 1922, pp. 249, 265 (type locality, New Zealand, in *Polycarpa pegasi* Mchlsn.).—Stephensen, 1927, pp. 379–381, fig. 33.—Sewell, 1949, p. 163.

Distribution: New Zealand.

Host: *Polycarpa pegasi* Mchlsn.

### *Doropygus kerguelensis* Schellenberg

*Doropygus trisetosus* var. *kerguelensis* Schellenberg, 1922, pp. 249, 266, fig. 28 (type locality, Kerguelen Island, in *Molgula* sp.).

*Doropygus kerguelensis* Sewell, 1949, p. 174.

Distribution: Kerguelen Island.

Host: *Molgula* sp.

## North American Species

### *Doropygus curvatus* Gray

*Doropygus curvatus* Gray, 1938, pp. 261–269, figs. 1–10 (type locality, Woods Hole, Mass., in *Styela partita* (Stimpson).—Lang, 1948, p. 6.—Sewell, 1949, p. 157.

DISTRIBUTION: Massachusetts.

HOST: *Styela partita* (Stimpson).

REMARKS: No specimens of this American species have been obtained for the present study. The original description furnishes all the details so far known about this notodelphyid.

### *Doropygus pulex* Thorell

? *Notodelphys ascidicola* Allman, 1847a, pp. 2–6, pl. 1, figs. 1–14, pl. 2, figs. 15–22 (part).

*Doropygus pulex* Thorell, 1859a, pp. 46–49, pl. 6, fig. 8 (type locality, Swedish coast in *Ascidia venosa, A. canina, A. aspersa, A. parallelogramma, Cynthia lurida*); 1859b, pp. 337, 339, 341–343; 1860, pp. 116, 118, 121, 122, 123.—Hesse, 1866, pp. 55–56.—Gerstaecker, 1870–1871, pp. 775, 776, 777, 801.—Brady, 1878, vol. 1, pp. 133–135, pl. 28, figs. 1–12.—Kerschner, 1879, pp. 184–185, pl. 1, fig. 4, pl. 2, figs. 4, 5, 9, pl. 3, fig. 9, pl. 6, figs. 10–12.—Richiardi, 1880, p. 147.—Aurivillius, 1882a, p. 54; 1882b, p. 111; 1883, pp. 24, 107–108.—Giesbrecht, 1882a, p. 324.—Carus, 1885, p. 342.—Herdman, 1889, pp. 248, 249; 1891, pp. 209–210; ?1898, pp. 254, 263.—Thompson, 1889, p. 185; 1893, p. 189, pl. 17, fig. 8.—Canu, 1891, p. 472; 1892, pp. 195–196, pl. 8, figs. 11–22, pl. 9, figs. 1–3.—T. Scott, 1900, p. 386; 1901, p. 351; 1907, pp. 363–364.—Graeffe, 1902, p. 39.—Thompson and Scott, 1903, p. 255.—Brian, 1905, p. 2, pl. 4, figs. 10–12.—Norman, 1905, p. 36.—Norman and Scott, 1906, p. 202.—Norman and Brady, 1909, pp. 400–401.—Pesta, 1909, p. 259.—Smith, 1909, p. 66, fig. 33.—Hartmeyer, 1911, pp. 1734–1735.—G. Sars, 1921, pp. 42–44, pl. 20.—Schellenberg, 1922, pp. 246–248, figs. 26, 27.—Stephensen, 1929, p. 6.—Harant, 1931, p. 370.—Marine Biological Association, 1931, p. 173.—Wilson, 1932, pp. 389–390, fig. 239.—Pesta, 1934, p. 8.—Leigh-Sharpe, 1935, p. 48.—?Wilson, 1935a, p. 779.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 119, fig. 68.—Gray, 1938, p. 261.—Stephensen, 1940, p. 20.—Sewell, 1949, pp. 157, 158, 160, 161, 169, 176, 177, 178, 182, 184, 191, 192.—Lang, 1948, pp. 2, 7; 1951, pl. 1, fig. 2.

*Doropygus pullus* Buchholz, 1869, pp. 116–119, pl. 6, fig. 3, pl. 7, fig. 3 (type locality, Naples).—Gerstaecker, 1870–1871, pp. 775, 804.

DISTRIBUTION: Mediterranean to Norway and Sweden, British Isles; West Africa; Faroës; Atlantic coast of North America, Barbados; Japan; Ceylon; Australia; New Zealand; ?Pacific coast of North America.

HOSTS: *Alloeocarpa thilesii* Mchlsn., *Ascidia aspersa, A. canina, A. mentula, A. parallelogramma, A. plebeia, A. venosa, Ascidiella scabra, A. opalina, Ciona intestinalis, Clavellina lepadiformis, ?Corella willmeriana, Cynthia lurida* Thorell, *C. morus* Linnaeus, *Microcosmus exasperatus* Hell. var. *australis*, Herdm., *M. oligophilus* Hell. var. *wahlbergi* Mchlsn., *Molgula oculata* Forb., *M. nodosa* Hartmr., *M. papillosa* Verrill, *Phallusia conchilega, P. obliqua, P. patula, P. virginea, Polycarpa atomaria, P. goréensis* Mchlsn., *P. obscura* Hell., *P. pomaria* Sav., *P. spongiabilis* Traust., *P. variabilis, Pyura japonica* Traust., *P. spinifera* (Q. u. Q.), *P. squamulosa, P. stolonifera* (Hell.).

*P. tesselata*, P. *trita* Sluit., ?*Styela gibbsii*, *S. gyrosa*, *S. loveni* (Sars), *S. plicata* Lsr., *Styelopsis grossularia* van Beneden, *Tethyum plicatum*, *T. rusticum*.

SPECIMENS EXAMINED:

MASSACHUSETTS

From ascidian:

Woods Hole, dredged in 6 fms., July 25, 1924, C. B. Wilson, 2 females.

FLORIDA

From ?*Styela plicata* (Lesueur):

Hurricane Harbor, Biscayne Key, growing on submerged test blocks, Mar. 23, 1950, L. B. Isham, 25-plus specimens.

BERMUDA

From *S. plicata*:

G. Hawes, 2 specimens.

DESCRIPTION: This species has been thoroughly illustrated by Canu (1892, pls. 8, 9) and G. Sars (1921, pl. 20). The American specimens conform well to the illustrations presented by Sars, except for minor features brought out in the description below.

Female: General features: The body is rather elongate, modified by the great expansion accommodating the brood sack. The pentamerous metasome includes the head, subequal free thoracic segments of the first to third swimming legs, and the inflated incubatory segment of the fourth legs. The urosome is 6-segmented. The somite of the fifth legs is apparently urosomal, although the anterodorsal portion is associated with the structure of the brood sack. The caudal rami are moderately short and simple in structure, with reduced armature. The apex of the head is produced midventrally as the well-developed rostrum.

Head appendages: The antennule is 8-segmented, with rather feebly developed setation. The two basal segments are the longest and by far the stoutest. A sharp taper brings about a graduated reduction of the mass of the proximal segments, so that the diameter of segment 6 is only a fourth or less of that of the first segment. The diameter of the two distal segments is subequal and the major differentiation of these in dimension is in length. Segment 7 is subquadrate and segment 8 is nearly twice as long as that preceding. In specimens from Florida, the antennule is 9-segmented, the terminal segment subdividing into two equal, subquadrate units. No seta of the appendage is particularly long, but the general armature is a weakly developed one for a species of *Doropygus*.

The 3-segmented antenna is slender. The basal segment is the longest and is relatively slim and linear. The second segment is relatively long, although it is the shortest segment of the appendage. The outline is mainly linear, although each margin is slightly convex. The distal segment is long and slender, the length approximating

four times the greatest width. The margins are more or less linear, the inner somewhat sinuate. The terminal articulated hook is a relatively large one. It is accompanied by two reduced setae inserted near the articulation of the hook.

The mandible consists of a 2-segmented protopodite and well-developed rami. The coxa is produced medially as the masticatory process. The basipodite is relatively short, and its armature consists of a single well-developed seta inserted terminally on the medial margin. The articulation of the endopodite is apical on the basipodite. This ramus is 2-segmented, the segments subequal and relatively good-sized. The basal segment bears a row of four graduated setae closely spaced and inserted at the medial distal corner. A complement of eight graduated setae form a marginal row, closely spaced, applied to the medial and apical margins of the distal segment. This row starts at a point on the medial margin about a fourth of the length of the segment distal from its articulation and the row extends around to the distal lateral corner of the subquadrate segment. Sars depicts a considerably more reduced setation for his Norwegian specimens.

The exopodite articulates on a wide emargination extending along the distal half of the lateral rim of the basis. The exopodite is well-developed and fairly long. It is obscurely 4-segmented. The armature consists of four well-developed setae, regularly inserted along the distal medial half and apex of the segment. All the setae of the mandible are plumose. A specimen from Woods Hole differs from the remaining American examples by the presence of a minute setule accompanying the apical seta.

The protopodite of the maxillule shows a considerable degree of coalescence, with no clear indication of the fundamental plan of its segmentation. The proximal endite is the usual flaring lobe set with a masticatory row of nine setae of varying dimensions. A second endite is represented by a narrowly triangular process extending along the apex of the proximal endite. The epipodite is reduced to a slight prominence bearing a well-developed principal seta accompanied by a rudimentary auxiliary setule. The plane of coalescence of the coxal portion of the protopodite with the basis is displaced to proceed almost longitudinally. The three long subequal setae assignable to the basipodite are inserted in a row along a truncate margin which is the distal boundary of the protopodite. The result of alteration of orientation is that both endopodite and exopodite are directed laterally. The small endopodite bears two setae. Of the four setae of the exopodite, a long proximal seta is well developed, with the remaining three somewhat reduced.

The slender maxilla is pentamerous. The protopodite is a single

segment bearing four rudimentary endites. The proximal process, doubtless representing an endite, is armed with three setae arranged in a characteristic row along a line at right angles to the axis of the appendage. Endite 2 has a single seta. Endite 3 bears a pair of equal setae. Endite 4 is the most produced and prominent and bears two subequal setae. The second segment bears two subequal setae and a vestigial setule. The distal seta, shorter and more rigid than its companion, is the homologue of the heavy claw-process of other genera. Segments 3 and 4 bear a single seta each. The terminal segment has three apical setae.

The maxilliped is obsoletely bimerous. The gnathal margin bears a proximal quartet and a distal quintet of setae. The distal, reduced segment is articulated somewhat subapically and laterally on the basal segment. The armature of the distal segment consists of two long, subequal setae.

Swimming legs: In the first legs the protopodite is extensive. The intercoxal plate is reduced almost to extinction. The coxa is ample, subquadrate; it bears a medial seta which extends slightly beyond the midpoint of the proximal segment of the exopodite. The distal margin of the basipodite is much indented to accommodate the articulations of the rami. The medial margin of the basipodite culminates in an expanded base supporting the usual articulated spine. This spine reaches to a point at about a level with the proximal third of the second segment of the endopodite. The usual lateral seta of the basipodite is fairly long and conspicuously expanded basally.

The major ornamentation of the trimerous exopodite consists of six spines and six setae. The basal segment bears a lateral spine, nearly distally directed, and a medial seta. The second segment bears a lateral spine and a medial seta. Of the four spines of the distal segment three are ranged along the lateral margin and one is apical. Of the setae of this segment, one is apical and three are inserted along the medial margin. The most basal and most distal spines are the longest and stoutest. The remaining four are subequal; that of the second segment is shortest.

The trimerous endopodite is ornamented with a single medial seta on the basal segment, a single medial seta on the second segment, and six setae on the distal segment. The disposition of these setae is as a medial row of three, two apical and one near the midpoint of the lateral margin.

The 2-segmented protopodites of the second legs are much extended. Most of the production is in the coxa. An intercoxal plate is present, but it is reduced. The inner coxal seta is a well-developed one and reaches well beyond the tip of the endopodite. The basis bears no readily detectable armature.

The exopodite is trimerous. All the elements of the armature markedly exhibit the general qualities of setae, although those in positions usually occupied by spines on appendages homologous to this are somewhat differentiated from the remainder and in the main lack the ciliation usually occurring in setae. The basal segment bears a medial typical seta and a lateral seta which occupies the position of the usual spine. The second segment bears a lateral and a medial seta. The distal segment bears three lateral setae, two apical setae, and four medial setae.

The endopodite is bimerous with strong indication of fusion of two elements to form the distal segment. The proximal segment bears one medial seta. The armature of the distal segment is composed of four setae along the medial margin, two apical setae, one seta set subterminally on the lateral margin, and one distinctly lateral seta.

The protopodite of the third leg very much resembles that in the second legs. The intercoxal plate is vestigial. The medial coxal seta is long, extending considerably beyond the endopodite. The basis bears no armature.

The armature of the trimerous exopodite consists of setae and the elongate setalike modifications of the usual spines. The basal segment bears a seta on the medial distal corner and one on the lateral distal corner. The second segment is similarly ornamented. The third segment bears three setae on the lateral margin, two apical setae, and four setae along the medial margin.

The endopodite is bimerous and the distal segment is somewhat produced. The basal segment bears a single medial seta. The distal segment has a medial row of four setae, two apical setae, one subterminal lateral seta, and a lateral seta.

The fourth legs exhibit the prolongation of the protopodites which occurs in the two preceding pairs. The intercoxal plate is indiscernible. The distal medial seta of the coxa exceeds the endopodite.

The exopodite is trimerous and the armature consists of slender setae. The basal segment bears a lateral and a medial seta. Segment 2 has a lateral seta and a medial seta. The distal segment has two lateral setae, two apical setae, and four medial setae, these eight members crowded into a compact row around the distal third of the segment.

The endopodite is bimerous. The basal segment bears a single medial seta. The distal segment bears three medial setae, three apical setae, and one lateral seta inserted at the distal third of the segment.

Short rows of minute spinules ornament the bases of some of the setae and portions of the margins of the segments of all the four pairs of swimming legs.

Vestigial legs and caudal rami: The fifth legs are bimerous. The homology of the protopodite here is not clear. The distal segment is elongate. The lateral margin is roughly linear, the medial margin is characterized by a series of emarginations. Complications of the integumentary structure form three characteristic spinule-like ornamentations of the emarginations. Two subequal setae are borne at the apex of the segment, the more medial markedly stouter and somewhat shorter. There are a few short spinules set just subapically on the median margin.

The length of each caudal ramus is roughly 4½ times its greatest width. The margins are rather smooth and there is a gentle taper to the rounded apex. There are four roughly equal, reduced apical setae. The lengths of the setae are about two-thirds the apical width of the ramus.

Male: No adult males were available in the present series of examples. Sars figured the habitus of the male and noted that in structural features of the appendages there is little disparity between the sexes.

Remarks: The recorded distribution of this species is the most widespread so far compiled for a notodelphyid. The list of hosts is also the most diverse and extensive known. Lang has pointed out that some of the variants described are probably specifically distinct forms. However, the verification of the record must await the intensive study of variation in a local population, coupled with investigation of a series representative of the extent of distribution. Present collections are too incomplete for this procedure to be followed practically as yet.

### *Doropygus laticornis* Wilson

Figure 4

*Doropygus laticornis* Wilson, 1932, pp. 388–389, pl. 1, fig. c, pl. 24, figs. a-g (type locality Woods Hole, Mass., in *Molgula manhattensis* (DeKay)).—Gray, 1938, p. 261.—Pearse, 1947, pp. 8–9, figs. 32–35.—Lang, 1948, p. 6.—Sewell, 1949, p. 157.

Specimens examined:

Massachusetts

From *M. manhattensis:*

Woods Hole, July 22, 1924, C. B. Wilson, holotypic female, 5 female paratypes.

From *Styela partita* (Stimpson):

Off Martha's Vineyard, dredged in 3–12 fms., July 1875, U. S. Fish Comm., 3 females.

North Carolina

From *Styela plicata* (Lesueur):

Fisheries Institute Pier, Bogue Sound, Morehead City, from pilings near surface at low tide, Feb. 14, 1951, W. H. Sutcliffe, Jr., 60-plus females.

Florida

From *S. plicata:*

Lemon Bay, Englewood, May 13, 1950, H. J. Humm, 20-plus females.

Gulf of Mexico, 3½ miles southwest of Longboat Pass, Sarasota Bay, dredged in 5–6 fms., Mar. 24, 1951, J. B. Knight, 30-plus females.

Alligator Harbor, Franklin County, Apr. 10, 1950, H. J. Humm, 5 specimens.

From *Bostrichobranchus digonas* Abbott:

Peace River estuary, Charlotte Harbor, stranded on beach, Sept. 18, 1950, J. C. Galloway, 15-plus females.

From *Molgula occidentalis* Traustedt:

Port St. Joe, November 1935, A. S. Pearse, 9 females.

Description: Female (figs. 4,*a–o*): General features: This species is a medium-sized *Doropygus*, considerably inflated, and with a relatively plastic body habitus (fig. 4,*a*). The integument often is very flexible, and distortion of the body in preserved specimens is commonly observed. The pentamerous metasome includes the head, three free thoracic somites, and the enlarged incubatory segment. In some specimens the brood sack has been noted to encroach considerably into the third free segment. The urosome (fig. 4,*b*) is 6-segmented, and can be dissected free of the urosome preserving attachment of the somite of the fifth legs. The caudal rami are elongate, and an extreme variant of the species has the longest rami of any American notodelphyid.

Head appendages: The obscurely 9-segmented antenule (fig. 4,*c*) is only slightly inflated basally. The first two segments are scarcely wider than long and the two together exhibit a uniform slight distal taper. The third, fourth, fifth, and sixth segments are each successively slightly diminished in width, telescope-wise. The terminal four segments participate in a fairly uniform taper from the base of the sixth segment. The articulations of the last three segments in the appendage are variable ones, with a tendency toward suppression of the last two joints. The insertion of the first segment on the head involves a wide area of articulation, which can be readily dissected away from the head with the appendage.

The armature of the antennule consists of varyingly reduced setae. From a single representative specimen the following approximation of a representative setation pattern was formulated: segment 1–3 setae: 2–12; 3–4; 4–4; 5–3; 6–3; 7–1; 8–3; 9–5. Notably stout and elongated setae are borne on the first, fifth, sixth, seventh, and ninth segments. Only two setae of the first segment, one of the second, and the long seta of the sixth segment are plumose.

The trimerous antenna (fig. 4,*d*) is stout and compact. The posture is a right-angled flexure. The basal segment is the longest. At the distal corner innermost at the flexure there is a slight prominence furnishing insertion for a pair of much reduced setules. The unorna-

mented second segment is slightly longer than wide. The outer margin is a slight convex curve. The inner margin is characterized by a semicircular bulge occupying the central half. The third segment is long and slender. Terminally articulated is a curved, tapered hook. Three setae are inserted near the base of the hook. Three more setae are inserted superficially at the distal third of the segment, near the outer margin. Near the outer margin at the proximal third is inserted a much reduced setule.

The coxopodite of the mandible (fig. 4,*e*) is produced medially to form a flattened masticatory lamella. Along the inner border of this plate are four markedly subequal tooth-like projections, a serrated blade expanse, and two short setiform projections. The basipodite and rami constitute a setiferous palp (fig. 4,*f*) with indications of segmentation considerably suppressed. A single seta is inserted on the medial margin of the basipodite slightly subterminally. The bimerous endopodite is somewhat tapered, forming in outline a truncated cone. Four setae are inserted in a distal row on the medial margin of the proximal segment. The armature of the apical segment consists of nine graduated setae arranged along the distal three-fourths of the medial margin and the whole of the distal border. A trio of these forms a rather compact lateral distal group.

The segmentation of the exopodite is much modified, with a distinctive arrangement of the four close-set setae. The unornamented basal segment is very long. The next four segments are short, much coalesced and each bears a distally inserted seta. This setiferous portion forms a terminal unit which proximally is somewhat enveloped by a flare-like expansion of the basal segment.

The protopodite of the maxillule (fig. 4,*g*) is somewhat obscurely demarcated into two segments. The basal segment bears two endites and an epipodite. The proximal endite expands to provide a long medial margin ornamented with nine variously developed masticatory setae. The second endite is a projection which furnishes a very wide insertion for a single elongate tapering setiform process. The margins of the process are ciliated. The epipodite is a subquadrate projection bearing a long, stout seta proximally and a distal reduced accessory setule.

The basipodite is produced medially as a broad lobe on which are inserted three slender, tapering, subequal setae. The endopodite bears three setae, two inserted along the distal margin and one medial. The exopodite bears three setae, inserted with close-set bases along the distal border of the ramus.

The pentamerous maxilla (fig. 4,*h*) forms in outline an elongated triangle. The medial margin of the basal segment is produced into four setiferous endites. The proximal endite bears three setae, their

bases transversely inserted in a close-spaced row. The second endite bears one seta. The third endite bears two equal setae. The fourth endite is well developed, exhibiting a subquadrate outline. Terminally inserted on it are two long, subequal setae accompanied by a setule. The second segment bears distally and medially a similar, subquadrate endite. The armature of this consists of two long setae and a reduced setule. The third segment is subquadrate in outline. Inserted at the distal medial corner is a single long seta. The fourth segment is subquadrate, with nearly parallel margins except for a slight distal medial projection furnishing insertion for a single long seta. The terminal segment is the smallest. It bears three subequal setae inserted apically.

The obscurely bimerous maxilliped (fig. 4,*i*) is a flattened, short, stout appendage. The basal segment is about 1½ times as long as wide with parallel margins. The distal medial border forms a semicircular curve. Two groups of setae are inserted medially. The basal group consists of three setae inserted on the margin. The distal group consists of four setae arranged in a row around the distal medial curve. A fifth seta is inserted on the surface of the segment just proximal to the ultimate seta of the row. The second segment is much reduced, articulated diagonally and markedly subapically on the distal lateral corner of the basal segment. There are two long setae inserted apically on the vestigial second segment.

Swimming legs: The first legs (fig. 4,*j*) consist of bimerous protopodites and trimerous rami. A well-developed intercoxal plate yokes the coxopodites. Inserted at the distal medial corner of the coxa is a long seta which extends to the distal margin of the second segment of the endopodite. The lateral marginal seta usually found on the basipodite of related species is here somewhat modified. On a greatly expanded basal half, the terminal half is set, preserving more usual setiform dimensions. Articulated on a strongly projecting base formed by the lateral distal corner of the basipodite is a stout tapered spine which reaches almost to the distal margin of the second segment of the endopodite. The basal segment of the exopodite bears a long, stout, tapered, lateral spine and a long medial seta. The second segment bears a lateral spine of about half the dimensions of that of the first segment and a medial seta. The third segment bears three nearly equal lateral spines about the size of the lateral spline on the second segment, an apical spine very slightly larger than that of the first segment, an apical seta, and three medial setae.

The two proximal segments of the endopodite each bear a medial seta. The distal segment bears three medial setae, two apical setae, and a lateral seta inserted in an emargination at about the midpoint of the edge of the segment. All setae of the first leg are plumose.

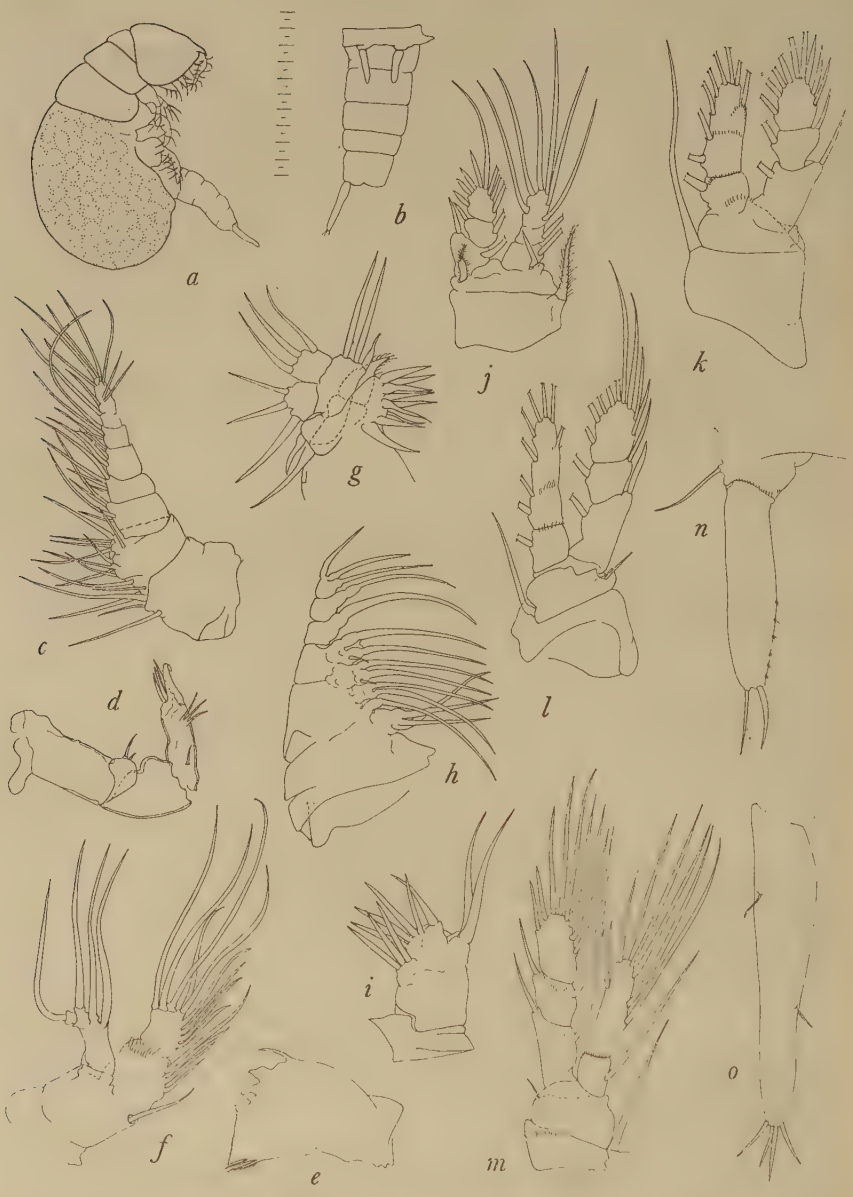


FIGURE 4.—*Doropygus laticornis* Wilson, female: *a*, habit, lateral view; *b*, urosome, *c*, antennule; *d*, antenna; *e*, masticatory lamella of mandible; *f*, palp of mandible; *g*, maxillule; *h*, maxilla; *i*, maxilliped; *j*, first leg; *k*, second leg; *l*, third leg; *m*, fourth leg; *n*, fifth leg; *o*, caudal ramus. The scale, referring to *a*, represents 1.0 mm.

The protopodites of the second legs (fig. 4,*k*) are yoked by a much reduced intercoxal plate. The coxopodites are elongated laterally so that the basal and distal articulations are divergent diagonals. Inserted on the distal medial corner of each coxa is a large, plumose seta extending well beyond the tip of the endopodite.

All the elements of the armature of the trimerous exopodite are of setiform construction, although proximally on the lateral margin these are short and somewhat rigid. All the lateral setae, the apical seta, and the one most distal medial seta lack plumose ciliation. The basal two segments each bear one lateral and one medial seta. The lateral seta of the basal segment is about equal in length to the segment. The lateral seta of the second segment slightly exceeds the segment. The distal segment bears three relatively short lateral setae, two long apical setae, and four long medial setae. All the segments of the exopodite are somewhat broadened.

The endopodite is bimerous but with strong indication of suppressed subdivision of the elongate distal segment. The proximal segment bears a single medial seta. The second segment bears five medial setae, two apical setae, and a lateral seta inserted at the distal third of the margin of the segment. Long spinules form rows on both segments of the endopodite and on the basipodite.

The third leg (fig. 4,*l*) consists of a bimerous protopodite, trimerous exopodite, and bimerous endopodite. Inserted on the distal medial margin of the coxopodite is a slender seta which extends to the proximal third of the second segment of the endopodite. The lateral marginal seta of the basipodite is reduced.

Each of the two proximal segments of the exopodite bears a short lateral seta (rather than a spine) and a medial seta. The distal segment bears three lateral setae, two apical setae, and four medial setae. All the segments of the exopodite are broadened and flattened. The basal segment is largest, nearly equaling the combined extent of the distal segment.

The endopodite extends to the level of the distal third of the exopodite. The proximal segment of the endopodite bears a single medial seta. The second segment bears five medial setae, two apical setae, and a lateral seta inserted at the distal third of the margin of the segment. A curved row of stout spinules ornaments the distal lateral corner of the first segment. A parallel row starts on the lateral margin of the second segment at the proximal one-third and continues on over the surface of the segment for most of its width. The four more proximal medial setae of the exopodite are plumose; all the setae of the endopodite except the terminal quartet are plumose.

The fourth leg (fig. 4,*m*) consists of a bimerous protopodite, trimerous exopodite, and bimerous endopodite. The segments of the protopodite are elongate and the articulation between them is displaced to run diagonally. Inserted on the distal medial corner of each coxa is a seta which extends about to the proximal fourth of the basal segment of the endopodite. The lateral marginal seta of the basipodite is somewhat reduced.

The segments of the exopodite are broadened and flattened. The basal segment is about equal to the combined extents of the two distal segments. The first segment bears a short lateral setiform spine and a medial seta. The second segment bears a similarly setiform spine and a medial seta. The third segment bears two short, lateral, setiform spines, an apical, much-elongated, heavy seta and an accompanying slender seta, and four medial setae. Only the medial seta of the first and second segments and the two proximal setae of the third segment are furnished with plumose ciliation.

The first segment of the endopodite bears a medial seta, which is slightly longer than the endopodite. The second segment bears four medial setae, two apical setae (the more lateral much shortened and rather stout), and a short stout seta inserted at the distal third of the lateral margin. A row of spinules is set along the distal lateral corner of the basal segment.

Vestigial legs and caudal rami: The fifth legs (fig. 4,*n*) are bimerous. The basal segment is unusually narrow, very slightly wider than long, tapering inward somewhat apically. On the distal medial corner and extending nearly to the lateral margin there is a row of numerous fine spinules. There is a well-developed lateral seta.

The second segment is slightly more than four times as long as wide, the slight distal taper being provided mainly by the curving lateral margin. There is a slender seta apically inserted, and slightly subterminal on the segment. At the distal point of the inner margin there is a slightly shorter, much stouter, curved seta. Five or six clusters of fine spinules are regularly arranged along the distal half of the medial margin.

The caudal rami (fig. 4,*o*) are long, slender, and markedly tapered. The apical width is a third of the basal, and the widest point of the ramus is at the proximal third. The length is five times the greatest width. There are four relatively well-developed setae arrayed across the apex. The longest of these slightly exceeds the greatest width of the segment. A seta of about half this length is inserted on the lateral margin at the proximal fourth. A similar seta is superficially inserted, nearly medially, just proximal to the terminal third.

No male was available for the present study.

Remarks: Of 19 females of this species collected at Morehead City, N. C., Feb. 14, 1951, 7 were immature in the last or next to last stadium, 12 had fully developed, empty brood sacks and the oviducts contained full-sized eggs. The eggs were rich salmon in color, closely matching the interior of the host, and the all-over color effect of the females was a flesh pink with salmon intensification along the oviduct. No coloration of the intestine was detected. Wilson recorded the color of this species at Woods Hole as yellowish.

The range of variations of this species as it occurs through its several hosts should be subjected to intensive study. An extremely great size range was noted in the present series. It seems possible that correlating other slight anatomical variations with distributional data might serve to provide a further taxonomic subdivision.

### *Doropygus demissus* Aurivillius

Figure 5

*Doropygus demissus* Aurivillius, 1885a, pp. 230–233, pl. 7, figs. 14–24 (type locality, off Pitlekaj, Siberia, in *Cynthia echinata* Linnaeus); 1885b, p. 282.—Hartmeyer, 1911, p. 1734.—Schellenberg, 1922, p. 240.—Wilson, 1920, p. 14.

Specimens examined:

Siberia
From *Boltenia echinata* (Linn.):
Plover Bay, Bering Sea, U. S. Coast Survey, W. H. Dall, 3 females.

Alaska
From *B. echinata:*
Off Point Barrow Base, Aug. 30, 1949, G. E. MacGinitie, 2 females.
Off Point Barrow Base, Sept. 6, 1949, G. E. MacGinitie, 6 females.
Off Point Barrow Base, Oct. 14, 1949, G. E. MacGinitie, 1 female.
Off Point Barrow Base, Sept. 6, 1950, G. E. MacGinitie, 2 females.
The Alaskan specimens were collected by G. E. MacGinitie while working for the Office of Naval Research as Scientific Director, Arctic Research Laboratory, through contracts with the California Institute of Technology and The Johns Hopkins University.

Canada
From *B. ovifera* (Linn.):
St. Lawrence Estuary, 1929, G. Préfontaine, 8 females.

Maine
From *Ascidia prunum* Mueller:
Lat. 42°25′40″ N., long. 60°08′35″ W., dredged in 12 fms., Aug. 31, 1883, *Albatross* Station 2064, 8 females.

Description: Female (fig. 5,*a–p*): General features: This species is a large, stout, trim copepod. The body is much inflated. The 5-segmented metasome (fig. 5,*a*) includes the head, three free thoracic segments, and the greatly expanded incubatory complex. The urosome is 6-segmented. The frontal margin of the head is midventrally produced as a stout, blunt rostrum.

Head appendages: The antennule (fig. 5,*b*) is distinctly 9-segmented and relatively slender. There is a marked basal expansion but this is developed to a considerably less degree than in nearly allied species. The two proximal segments are long and of fairly uniform thickness over the combined lengths. Each of the next four segments is characterized by a marked diminution of thickness from that of the preceding segment. The seventh segment is constricted basally but its maximum width is nearly as great as that of the sixth segment. The eighth and ninth segments are about of equal width. The majority of the setae lack ciliation. However, long plumose setae form distinctive features of the first, second, fourth, fifth, and sixth segments. The plumose seta of the sixth segment is the longest and stoutest of the entire appendage.

The setation of a representative specimen provides an approximation of that usual for the species: Segment 1–3 setae; 2–10 plus; 3–5; 4–3; 5–4; 6–4; 7–2; 8–2; 9–5.

The margins of the long, slender basal segment of the trimerous antenna (fig. 5,*c*) are nearly parallel. Distally on this segment toward the inner side of the flexure of the appendage there is a short prominence with two fine filamentous apical projections which correspond to reduced setules. The second segment is slightly curved, so that its outer margin is much longer than the inner, and the articulations are somewhat diagonal. The distal portion of the inner margin expands prominently in a bulge approaching a semicircular outline. The distal segment is long and slender with nearly parallel margins. Articulated apically on this segment is a stout tapered curved hook. The hook has a characteristic, somewhat flexed posture and is terminated with a flangelike flare of the integument rather than the usual sharp point. Three rather reduced setae are inserted near the articulation of the hook. Just beyond the distal half of the segment there are inserted the close-set bases of two setae which are held closely appressed along the surface of the segment.

The coxopodite of the mandible (fig. 5,*d*) is extended medially to form a flattened masticatory blade. The inner margin of this blade is differentiated as five tooth-like prominences, a short saw-edge, and two setiform projections. The basipodite and the rami form a setiferous palp. The single seta of the basipodite is inserted subterminally on the medial margin. The basal segment of the bimerous endopodite is ornamented with four graduated setae which are arranged around the distal medial corner. The distalmost of these setae is very long and protrudes beyond the distal end of the terminal segment of the endopodite for slightly over twice again the length of that segment. Ten setae form an inverted L-shaped row along the major portion of the medial margin and all the terminal border

of the second segment of the endopodite. The exopodite is a relatively short, distinctly stocky cone, indistinctly bimerous. An apical trio of subequal setae ornaments the distal segment. A long seta is inserted at the midpoint of the anatomically medial margin of the basal segment and another seta is set at the distal medial corner of this segment.

The protopodite of the maxillule (fig. 5,*e*) presents an aspect suggesting distinct subdivision into coxopodite and basipodite. The proximal segment bears two endites and the epipodite. The basal endite is wide-flaring medially and its inner margin is armed with a close-set row of nine masticatory setae of varying proportions. Just distal to this endite, and much obscured by the overlying distal-medial flare of the basal endite, is a prominence representing the second endite. This is produced as an elongate, flat, tapering blade, expanded basally. The margins are profusely ciliated. The epipodite is represented by a slight prominence bearing a long, stout, curved seta and a reduced accessory tapering setule. The seta is proximally directed. The basipodite has the medial margin displaced distally and laterally. The lateral margin is reduced to obsolescence. There are three graduated setae inserted on the anatomically medial margin of the basis and they are directed distally. The rami are so disposed as to project almost laterally. The endopodite bears three setae, two inserted along the medial margin and one apical. The exopodite bears three stout setae inserted fan-wise along the wide outer margin in specimens examined which were found associated with *Boltenia echinata* from Point Barrow, Alaska. Specimens obtained from *Boltenia ovifera*, from the St. Lawrence estuary, Canada, were characterized by the presence of a wisp of a setule inserted between the bases of the two farthest lateral setae of the ramus (fig. 5,*f*). In specimens taken from *Boltenia echinata* from Plover Bay, Siberia, the exopodite (fig. 5,*g*) bears four well-developed setae. Otherwise specimens from the three localities correspond with each other extremely closely. The setation of the maxillular exopodite has been held as a fairly distinctive feature in notodelphyid species. The significance of the transitional series in the present material is not readily apparent.

The pentamerous maxilla (fig. 5,*h*) is a much-flattened structure with a very slender, tapering triangular outline. The basal segment is a truncated cone with the basal width roughly twice that at the distal articulation. The medial margin of this segment is elaborated into four setiferous endites. The proximal endite bears three setae with their bases transversely inserted. The second endite bears a single seta. The third endite bears two equal setae. The fourth endite is much produced and it bears two equal setae and a minute

FIGURE 5.—*Doropygus demissus* Aurivillius, female: *a*, habit, lateral view; *b*, antennule; *c*, antenna; *d*, mandible; *e*, maxillule; *f*, exopodite of maxillule with rudimentary seta; *g*, exopodite of maxillule bearing four setae; *h*, maxilla; *i*, maxilliped; *j*, first leg; *k*, spine from exopodite of first leg; *l*, second leg; *m*, third leg; *n*, fourth leg; *o*, fifth leg; *p*, caudal ramus. The scale, referring to *a*, represents 1.0 mm.

accessory setule. The second segment is about as long as broad and is produced medially as a single endite. The armature of this consists of a stout, spiniform process, a typical seta, and a short accessory setule. The spiniform process, somewhat shorter than the seta, preserves in its marked sclerotization, slightly reduced length, and serrate proximal margin strong indication that it is the homologue of the usual stout hook-process of this segment in most other notodelphyid species. Each of the succeeding two segments bears a single distal medial seta. The terminal segment bears three apical setae, and a fourth seta inserted superficially near the base of the segment. The terminal complex of three segments is much elongated, the combined lengths equaling fully twice the length of the second segment. The fourth segment contributes mainly to this arrangement, its length being twice its width.

The bimerous maxilliped (fig. 5,*i*) is much flattened, short and stout in outline. The basal segment bears two groups of setae. Five setae are disposed around the distal medial margin. A second group of four setae are inserted near the midpoint of the medial margin. Displaced far laterally on the surface of the segment is the insertion of one differentiated seta in each of the two groups. These setae are stout, heavily sclerotized, disposed in a characteristic curve and ornamented with a profuse ciliation. The distal segment is a stout, short, truncated cone, articulated at the distal lateral corner of the basal segment. Its two apical setae are subequal, long, plumose. Medial to the insertion of this second segment the distal margin of the first segment is ornamented by a number of distinctive, long, stout hairs, which form a row extending to near the base of the terminal seta of the segment. The optical effect of these hairs when they are at all matted together and superficially viewed is remarkably like that of a short plumose seta inserted on the medial margin of the distal segment. Such a structure was depicted by Aurivillius in the illustrations accompanying the original description of this species. It is proposed that this feature was based upon such an error of observation.

Swimming legs: The first legs (fig. 5,*j*) consist of bimerous protopodites and trimerous rami. The coxopodites are yoked by an intercoxal plate, triangular in outline and heavily sclerotized, particularly at the apex. Inserted on the distal medial corner of the coxa is a long, profusely ciliated seta which extends to the distal margin of the endopodite. The armature of the basipodite consists of a medial spine. This spine, inserted at the distal medial corner of the basis, is stout and tapered, extending to the distal margin of the second segment of the endopodite.

The segments of the exopodite are constricted basally. The two proximal segments bear each a lateral spine and medial seta. The distal segment bears three lateral spines, an apical spine and seta, and three medial setae. The spines of the exopodite are subequal, except that the terminal spine of the distal segment is half again as long as the next longest. Each spine (fig. 5,*k*) is stout, tapered, and provided with a narrow, unusually finely serrate marginal transparent flange. The margin of each segment proximal to the insertion of the spine, or set of spines, is markedly spinulose.

The two proximal segments of the endopodite each bear a medial seta. The distal segment bears three medial setae, two apical setae, and a lateral seta which is inserted in an emargination at about the midpoint. All the setae of the endopodite are plumose. Stout spinules are set in rows along the lateral two-thirds of the distal margin of each of the two proximal segments of the endopodite.

The protopodite of the second leg (fig. 5,*l*) is produced and narrowed, with regularly transverse articulation of coxa and basis. The intercoxal plate of other species is here obsolescent. At the distal medial corner of the coxa is inserted a very long, plumose seta which extends almost to the midpoint of the distal segment of the endopodite.

The basal segment of the trimerous exopodite is elongated and bears a lateral seta and a medial seta. The second segment has a lateral and a medial seta. The distal segment bears three lateral setae, two apical setae, and four medial setae. All the lateral setae and the outer distal one are in positions usually occupied by spines, but these members are thoroughly setiform, with the only distinctive feature a slightly reduced length.

The bimerous endopodite extends slightly beyond the exopodite. The basal segment bears a single medial seta. The elongate distal segment is armed with five medial setae, two apical setae, and a lateral seta. Fine spinules provide additional armature on all the segments of the rami and on the basipodite. The three most basal medial setae of the exopodite and all but the distalmost setae of the endopodite are plumose.

In the elongated bimerous protopodites of the third legs (fig. 5,*m*) the articulation of coxa and basis is somewhat diagonal due to elongation of the outer margin of the coxa. Inserted on the medial distal corner of the coxopodite is a long plumose seta which extends to the level of the basal third of the distal segment of the endopodite. There is a reduced setule inserted near the lateral margin of the basipodite.

The segments of the trimerous exopodite are slightly broadened and flattened. The basal segment is well exceeded by the combined extents of the distal two segments. The armature consists entirely of setiform elements. The basal segment bears a lateral seta and a

medial seta. The second segment bears a lateral and a medial seta. The distal segment bears three lateral setae, two apical setae, and three medial setae.

The bimerous endopodite is about equal in extent to the exopodite. The first segment bears a medial seta. The long distal segment bears five medial setae, two apical setae, and a lateral seta inserted in an emargination just about at the distal fourth of the margin. Fine spinules arranged in curved rows and clusters furnish additional ornamentation of the appendage. The most basal setae of the medial margin of the exopodite and all but the most apical three setae of the endopodite are plumose.

The bimerous protopodite of the fourth leg (fig. 5,*n*) is elongated with a slightly diagonal articulation of the two segments produced by prolongation of the lateral margin of the coxopodite. Inserted on the distal medial corner of the coxopodite is a well-developed plumose seta reaching just about the midpoint of the endopodite. A minute reduced seta is inserted in the short lateral margin of the basipodite.

The three segments of the exopodite are flattened, but relatively slender. The basal segment is much elongated in addition so that it approximately equals the combined extents of the distal two segments. All the elements of the armature are setiform but the two most proximal lateral ones are short. The basal segment bears only a very short seta, inserted at the distolateral corner and a normally long medial seta. The second segment bears a lateral seta, relatively short, and a medial seta. The distal segment bears three lateral setae, two apical setae, and four medial setae.

The bimerous endopodite reaches about to the proximal third of the distal segment of the exopodite. The basal segment bears a single medial seta, fairly elongate, extending beyond the tip of the ramus. The second segment bears four medial setae, two apical setae, and a lateral seta inserted at the distal fourth of the margin. Curved rows and patches of fine spinules furnish additional ornamentation to the segments of the appendage. The most proximal three medial setae of the exopodite and all but the apical quintet of setae of the endopodite are plumose.

Vestigial legs and caudal rami: The fifth leg (fig. 5,*o*) is bimerous. The basal segment is longer than wide. The ornamentation consists of a short row of five or six fairly long spinules arranged on the surface of the segment near the distal medial corner. The second segment is about five times as long as its width at the midpoint, and markedly tapered. The apex is acute and is set with a slender seta. Slightly subapical and medial is a somewhat shorter second seta. Short rows of fine spinules arranged on the surface of the segment and extending to the medial margin furnish additional ornamentation.

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The caudal rami (fig. 5,*p*) are slender and relatively long, about five times as long as their greatest width. They taper only slightly distally. The ornamentation is reduced to an apical group of merest vestiges of setules.

No male has yet been found.

REMARKS: The combination of circumstances presented by the distribution of this copepod and the frequently noted host, *B. echinata*, suggest strongly that it is the form described by Aurivillius from the Vega collections. There are some features of the anatomy which do not correspond with Aurivillius' figures, but the inconsistencies could well be due to the lack of detail supplied in these early sketches. The antennule of *Doropygus demissus* was depicted as 13-segmented. No *Doropygus* is known with this feature and the appendage, as depicted, could hardly be homologized with the basic notodelphyid antennule, which is a remarkably consistent structure. The form of the maxilliped was remarked upon under the description above. The remainder of Aurivillius' illustrations conform fairly well, as generalizations, to the structures of the present specimens.

*Doropygus demissus* has not been reported since the original description. Dr. Karl Lang, Director of the Invertebrate Collections at the Naturhistoriska Riksmuseet, Stockholm, has kindly informed me that Aurivillius' specimen is not in that museum, nor in that of Uppsala University. It is therefore concluded that this type has not been preserved. Accordingly, it seems entirely justifiable to apply the above emendations to Aurivillius' description and attach his name to these Arctic Boreal copepods.

### *Doropygus bayeri*, new species

FIGURE 6

TYPES.—Holotypic female, USNM 92802 (type locality, Washington Sound, Washington, in *Pyura haustor* (Stimpson)); allotypic male, No. 92803, same collection, and paratypes listed below.

SPECIMENS EXAMINED:

WASHINGTON

From *P. haustor:*

East of Upright Channel, dredged in 25–35 fms., June 22, 1950, holotypic female, allotypic male, 34 paratypes.

East of Upright Channel, 25–35 fms., June 23, 1950, 65 females.

Near Canoe Island, off Shaw Island, dredged, July 1, 1950, 43 females.

North of east end of Lopez Pass, dredged, July 15, 1950, 42 females.

BRITISH COLUMBIA

From *Pyura* sp:

Off Cadboro Bay, dredged in 18 fms., Sept. 8, 1937, W. Williams, American Museum of Natural History 6926, 2 females.

California
From *?Pyura* sp:
San Diego Bay, 6 fms., Mar. 31, 1896, *Albatross*, 18 females.
From unidentified tunicate:
Off National City, Jan. 29, 1889, *Albatross*, 8 specimens.

Description: Female (fig. 6,*a–n*): General features: This species is a rather small-bodied *Doropygus*, with a notable tendency to inflation (fig. 6,*a*). The segmentation is somewhat suppressed. These features, combined with the usual soft texture of the integument, frequently lead to considerable distortion in preserved specimens. The usual posture is a partially contracted one. The urosome is relatively pliable and usually lies in close conformation with the major The usual posture is a partially contracted one. The urosome is relatively pliable and usually lies in close conformation with the major mass of the body.

The anteriormost portion of the head is produced ventrally as a substantial rostrum.

Head appendages: The antennule (fig. 6,*b*) is 9-segmented and relatively slender. There is a marked basal expansion but this is developed to a considerably less degree than in nearly allied species. The two proximal segments are long and of fairly uniform thickness over the combined lengths. Each of the next four segments is characterized by a marked diminution of thickness from that of the preceding segment. The seventh segment is constricted basally but its maximum width is nearly as great as that of the sixth segment. The eighth and ninth segments are about of equal width. The majority of the setae lack ciliation. However, long plumose setae form distinctive features of the first, second, fourth, fifth, and sixth segments. The plumose seta of the sixth segment is the longest and stoutest of the entire appendage. The setation of a representative specimen provides an approximation of that typical for the genus: Segment 1–3 setae; 2–12 plus; 3–5; 4–5; 5–4; 6–4; 7–1; 8–3; 9–6.

The trimerous antenna (fig. 6,*c*) is disposed in a nearly right-angled flexure. The margins of the long, slender basal segment are nearly parallel. Distally on this segment toward the inner side of the flexure there is inserted a short stublike setule with two fine filamentous apical projections. The second segment is slightly curved, so that its outer margin is much longer than the inner; its articulations are somewhat diagonal. The distal portion of the inner margin expands prominently in a bulge approaching a semicircular outline. The distal segment is long and slender with nearly parallel margins. Articulated apically on this segment is a stout tapered curved hook. Three rather reduced setae are inserted near the articulation of the hook. At the distal sixth of the segment there are inserted the close-

set bases of two setae which are held closely appressed along the surface of the segment.

The coxopodite of the mandible is extended medially to form a flattened masticatory blade (fig. 6,*d*). The inner margin of this blade is differentiated as four tooth-like prominences, a short saw-edge, and two setiform projections. The basipodite and the rami form a setiferous palp (fig. 6,*e*). The single seta of the basipodite is inserted subterminally on the medial margin. The basal segment of the bimerous endopodite is ornamented by four graduated setae which are arranged around the distal medial corner. Nine setae form an inverted L-shaped row along the major portion of the medial margin and all the terminal border of the second segment of the endopodite. The exopodite is truncated apically with a subterminal flare, so that the base is constricted. The five setae are arranged as a close-set row across the diagonal distal margin. Segmentation of the ramus is obsolete, although there are some conspicuous grooves in the integument.

The protopodite of the maxillule (fig. 6,*f*) presents an aspect suggesting subdivision into coxopodite and basipodite. The proximal segment bears two endites and the epipodite. The basal endite is wide-flaring medially and its inner margin is armed with a close-set row of nine masticatory setae of varying proportions. Just distal to this endite, and much obscured by the overlying distal medial flare of the basal endite, is a prominence representing the second endite. This is produced as an elongate, flat, tapering blade, much-expanded basally. The margins are profusely ciliated. The epipodite is represented by a slight prominence bearing a long stout seta and a reduced accessory setule. The seta is proximally directed. The basipodite has the medial margin displaced distally and laterally. The lateral margin is reduced to obsolescence. There are three graduated setae inserted on the anatomically medial margin of the basis and they are directed distally. The rami are so disposed as to project almost laterally. The endopodite bears three setae, two inserted along the medial margin and one apical. The exopodite bears three stout setae inserted fan-wise along the wide outer margin.

The pentamerous maxilla (fig. 6,*g*) is a much-flattened structure with a slender, tapering triangular outline. The basal segment is a truncated cone with the basal width 2½ times that at the distal articulation. The medial margin of this segment is elaborated into four setiferous endites. The proximal endite bears three setae with their bases transversely inserted. The second endite bears a single seta. The third endite bears two equal setae. The fourth endite is much produced and it bears two equal setae and a minute accessory setule. The second segment is longer than broad and is produced medially as

FIGURE 6.—*Doropygus bayeri*, new species, female: *a*, habit, lateral view; *b*, antennule; *c*, antenna; *d*, masticatory lamella of mandible; *e*, palp of mandible; *f*, maxillule; *g*, maxilla; *h*, maxilliped; *i*, first leg; *j*, second leg; *k*, third leg; *l*, fourth leg; *m*, fifth leg; *n*, caudal ramus. The scale, referring to *a*, represents 1.0 mm.

a single endite. The armature of this consists of two subequal setae and a short accessory setule. The distal seta is sclerotized and slightly reduced in length. Each of the succeeding two segments bears a single distal medial seta. The terminal segment bears three apical setae.

The bimerous maxilliped (fig. 6,*h*) is much flattened, short and stout in outline. The basal segment bears two groups of setae. Five setae are disposed around the distal medial margin. A second group of four setae are inserted near the midpoint of the medial margin. Displaced far laterally on the surface of the segment is the insertion of one differentiated seta in each of the two groups. These setae are stout, heavily sclerotized, disposed in a characteristic curve and ornamented with a profuse ciliation. The distal segment is so reduced as to constitute little more than a minute setiferous prominence at the distal lateral corner of the basal segment. Its two setae are subequal, long, plumose. Medial to the insertion of this second segment the distal margin of the first segment is ornamented by a number of distinctive long stout hairs which form a row extending to the base of the most distal seta of the segment.

The first legs (fig. 6,*i*) consist of bimerous protopodites and trimerous rami. The coxopodites are yoked by an intercoxal plate, triangular in outline and heavily sclerotized in a complicated pattern. Inserted on the distal medial corner of the coxa is a long, profusely ciliated seta which extends almost to the distal margin of the endopodite. The armature of the basipodite consists of a lateral seta and a medial spine. The seta is long, stout basally with a constriction in outline at about the midpoint. It is inserted distally on the short lateral margin of the basis. The medial spine, inserted at the distal medial corner of the basis, is slender and curved, extending slightly beyond the distal margin of the basal segment of the endopodite.

The segments of the exopodite are markedly constricted basally. The two proximal segments bear each a lateral spine and medial seta. The distal segment bears three lateral spines, an apical spine and seta, and three medial setae.

The two proximal segments of the endopodite bear each a medial seta. The distal segment bears three medial setae, two apical setae, and a lateral seta which is inserted in an emargination at about the distal fourth of the segment. Rows of fine spinules form additional ornamentation on the segments of the rami and on the basipodite.

The protopodites of the second legs (fig. 6,*j*) are produced and narrowed. The articulation of coxa and basis is somewhat diagonal. A vestige of an intercoxal plate connects the basal portions of the coxopodites. At the distal medial corner of the coxa is inserted a very long, plumose seta which extends well beyond the distal margin of the

endopodite. A short seta is inserted near the short lateral margin of the basipodite.

The basal segment of the trimerous exopodite is greatly elongated and bears a lateral seta and medial seta. The second segment has a lateral and a medial seta. The distal segment bears three lateral setae, two apical setae, and four medial setae. All the lateral setae and the outer distal one are in positions usually occupied by spines, but these members are thoroughly setiform, with the only distinctive feature a slightly reduced length.

The bimerous endopodite is not quite as long as the exopodite. The basal segment bears a single medial seta. The elongate second segment is armed with five medial setae, two apical setae, and a lateral seta. Fine spinules provide additional armature on all the segments of the rami and on the basipodite.

The elongated bimerous protopodites of the third legs (fig. 6,*k*) are united by a vestigial intercoxal plate. The articulation of coxa and basis is somewhat diagonal, due to elongation of the outer margin of the coxa. Inserted on the medial distal corner of the coxopodite is a long seta which extends just beyond the tip of the endopodite. There is a reduced seta inserted near the lateral margin of the basipodite.

The segments of the trimerous exopodite are broadened and flattened. The basal segment about equals the combined extents of the distal two segments. The armature consists entirely of setiform elements. The basal segment bears a single lateral seta. The second segment bears a lateral and a medial seta. The distal segment bears three lateral setae, two apical setae, and four medial setae.

The bimerous endopodite reaches just beyond the distal margin of the second segment of the exopodite. The first segment bears a medial seta. The long distal segment bears five medial setae, two apical setae, and a lateral seta inserted in an emargination just beyond the distal fourth of the margin. Fine spinules arranged in curved rows and clusters furnish additional ornamentation of the appendage.

The bimerous protopodites of the fourth legs (fig. 6,*l*) are elongated with a diagonal articulation of the two segments produced by prolongation of the lateral margin of the coxopodite. The coxae are united by an almost obsolete vestige of the usual intercoxal plate. Inserted on the distal medial corner of the coxopodite is a well-developed seta reaching just beyond the midpoint of the endopodite. A reduced seta is inserted in the short lateral margin of the basipodite.

The three segments of the exopodite are broadened and flattened. The basal segment is much elongated in addition, so that it approximately equals the combined extents of the distal two segments. All the elements of the armature are setiform. The basal segment bears

only a single seta, inserted at the distolateral corner. The second segment bears a lateral seta and a medial seta. The distal segment bears two lateral setae, two apical setae, and four medial setae.

The bimerous endopodite reaches just to the distal margin of the second segment of the exopodite. The basal segment bears a single medial seta, considerably reduced, so as to be shorter than the distal segment. The second segment bears four medial setae, two apical setae, and a lateral seta inserted at the distal quarter of the margin. The two proximal setae are short, neither equaling the length of the segment. Curved rows and patches of fine spinules furnish additional ornamentation to the segments of the appendage.

The fifth leg (fig. 6,*m*) is bimerous. The basal segment is wider than long and articulates somewhat diagonally with the distal segment. The ornamentation consists of numerous short curved rows of fine spinules arranged on the surface of the segment near the distal medial corner. The second segment is about three times as long as its greatest width, and somewhat tapered. The apex is acute and is set with a short slender seta. Slightly subapical and medial is a second seta of about the same dimensions. Short rows of fine spinules arranged on the surface of the segment and extending to the medial margin furnish additional ornamentation.

The caudal rami (fig. 6,*n*) are short, about three times as long as their greatest width. They taper considerably distally and there is a strong tendency toward roughly spiral coiling of the apical third of the ramus. Four equal short setules are inserted on the apex. The setae are about equal in length to the width of the ramus at the insertion of the most proximal of the four setae. At the basal fifth of the ramus there is inserted near the lateral margin a fifth equally reduced seta.

Male: There is no outstandingly notable feature in the male of this species. The body of course lacks the expansion occasioned by the presence of the brood sack in the female. The antennule remarkably resembles that in the female except for the possession of a stout curved spine inserted on the outer margin of the second segment. The homologue of this member, on a considerably less developed scale, is present in the female, however. The swimming legs resemble those of the female in segmentation, but in proportion and ornamentation they are of much more generalized cyclopoid type, although still with poorly differentiated spines. The setae missing on the posterior exopodites in the female are present in the male. The urosome is modified in accordance with the presence of the reproductive structures. The sixth legs are represented by the usual bisetiferous integumentary prominences.

***Doropygus fernaldi*, new species**

FIGURE 7

TYPES: Holotypic female, USNM 92804 (type locality, Washington Sound, Washington, from *Boltenia villosa* (Stimpson)); allotypic male, No. 92805; paratypes listed below.

SPECIMENS EXAMINED:

WASHINGTON

From *B. villosa:*

Upright Channel, dredged, June 23, 1950, holotypic female, allotypic male, 5 female paratypes.

Obstruction Pass, Orcas Island, dredged, Aug. 18, 1948, R. L. Fernald, 3 females.

Upright Channel, June 23, 1950, 5 specimens.

Mitchell Bay, San Juan Island, from floats, July 12, 1950, 1 female.

Just north of east end of Lopez Pass, July 15, 1950, 1 female.

Upright Channel, dredged, July 19, 1950, 2 females.

DESCRIPTION: Female (fig. 7,*a–m*): General features: This large species (fig. 7,*a*) is relatively stout-bodied, with markedly reduced caudal rami. The metasome is distinctly 5-segmented, consisting of the head, three free thoracic somites, and the large incubatory segment. The urosome is 6-segmented and includes the somite of the fifth legs. The head is produced anteriorly at the midventral line as a conspicuous rostrum.

Head appendages: The 9-segmented antennule (fig. 7,*b*) is enormously inflated basally. The first two segments are much wider than long and the two together exhibit a uniform slight distal taper. The third, fourth, fifth, and sixth segments are each successively markedly diminished in width, telescopically. The terminal four segments participate in a fairly uniform taper from the base of the sixth segment. Various of the articulations in the appendage are very complicated ones, with a tendency toward a sleevelike overlap of the more proximal segments over the bases of those next distal. The insertion of the first segment on the head involves a wide area of articulation, sclerotized and well-delimited, which can be readily dissected away from the head with the appendage. The extent of overlapping of segments, of course, would vary with the posture of the appendage. The usual aspect in the preserved specimen has some characteristic features which can, with some validity, be compared to the condition of the antennule in other species. The basal segment overlaps about one-half the second. The second segment envelops the proximal third of segment 3. The third segment envelops about a quarter of segment 4. The overlaps of the fourth segment on the fifth and the fifth segment on the sixth are complicated diagonals, producing articulations which must involve restriction of the planes of motion of the terminal part of

the antennule. The articulations of the four terminal segments do not involve overlapping.

The armature of the antennule consists mostly of much-reduced setae. Notably stout and elongated setae are borne on the first, fifth, sixth, seventh, and ninth segments.

The trimerous antenna (fig. 7,*c*) is stout and compact. The posture is a right-angled flexure. The basal segment is the longest. At the distal corner innermost at the flexure there is a slight prominence furnishing insertion for a pair of much-reduced setules. The unornamented second segment is slightly longer than wide. The outer margin is a slight convex curve. The inner margin is characterized by a semicircular bulge occupying the central two-thirds. The third segment is long and slender. Terminally articulated is a curved, tapered hook. Four setae are inserted near the base of the hook. Three more setae are inserted at the distal third of the segment, on its surface, near the outer margin. Near the outer margin at the proximal third is inserted a much-reduced setule.

The coxopodite of the mandible is produced medially to form a flattened masticatory lamella. Along the inner border of this plate are four subequal toothlike projections, a serrated blade expanse, and two short setiform projections. The basipodite and rami constitute a setiferous palp (fig. 7,*d*). A single seta is inserted on the medial margin of the basipodite at about the distal sixth. The bimerous endopodite is much tapered, forming in outline a truncated cone. Four setae are inserted in a row around the distal medial corner of the proximal segment. The armature of the apical segment consists of ten graduated setae arranged along the distal three-fourths of the medial margin and the whole of the distal border.

The exopodite is pentamerous, with a distinctive arrangement of the five closely set setae. The unornamented basal segment is the longest. The next three segments are short and each bears a distally inserted seta. The minute terminal segment bears the remaining two setae.

Near the articulations of the maxillules and medial to their bases are a pair of well-developed paragnaths. Each paragnath reaches about to the midpoint of the protopodite of the maxillule. Each paragnath is a rounded triangle in outline. The integument is furred with fine ciliation. The sternal integument between the bases of the paragnaths is roughened by a symmetrical patch of fine scalelike denticulations.

The protopodite of the maxillule (fig. 7,*e*) is well demarcated into two segments. The basal segment bears two endites and an epipodite. The proximal endite expands to provide a long medial margin ornamented with variously developed masticatory setae. The second

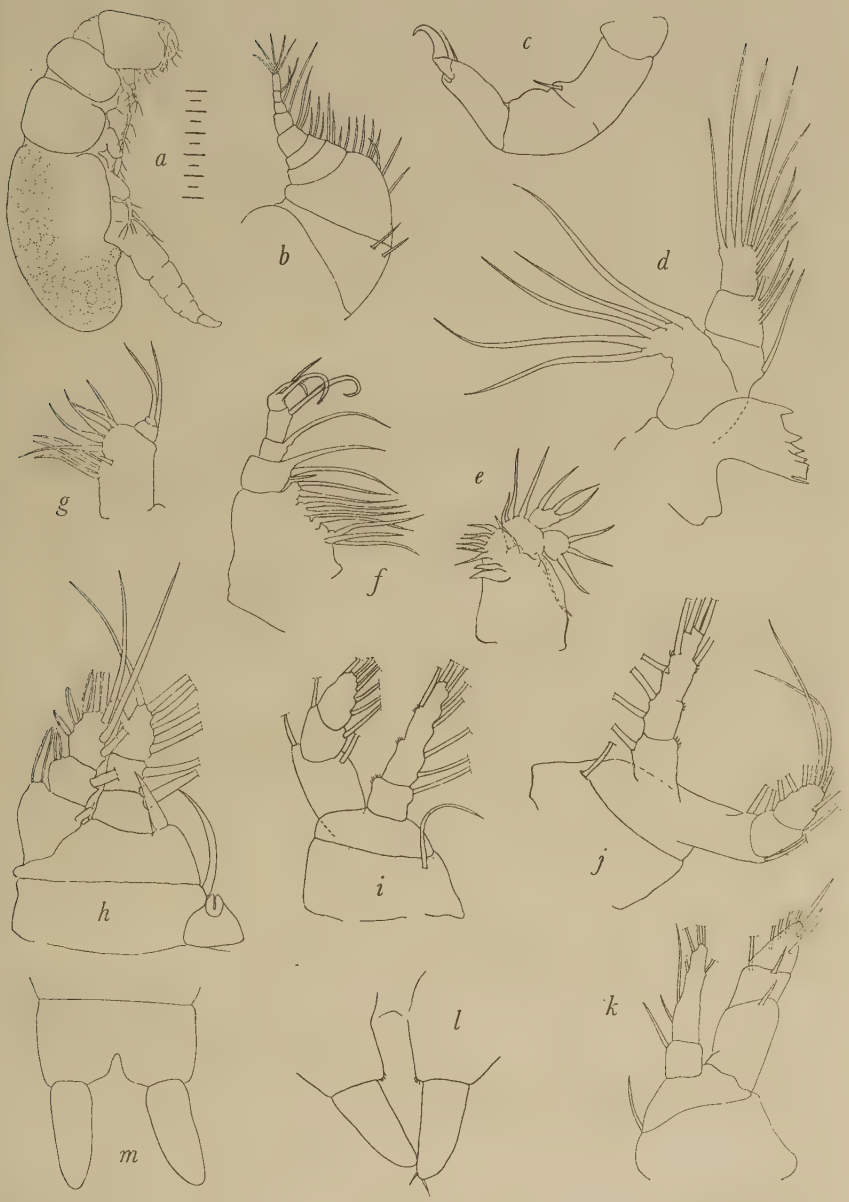


FIGURE 7.—*Doropygus fernaldi*, new species, female: *a*, habit, lateral view; *b*, antennule; *c*, antenna; *d*, mandible; *e*, maxillule; *f*, maxilla; *g*, maxilliped; *h*, first leg; *i*, second leg; *j*, third leg; *k*, fourth leg; *l*, fifth leg; *m*, caudal rami. The scale, referring to *a*, represents 1.0 mm.

endite is a projection which furnishes insertion for a single elongate tapering setiform process. The epipodite is so coalesced with the main mass of the protopodite as to constitute no more than a place of insertion for a long, stout seta and a reduced accessory setule.

The basipodite is produced medially as a broad lobe on which are inserted three long, tapering, subequal setae. The endopodite bears three setae, two inserted along the medial margin, one apical. The exopodite bears three setae, inserted with close-set bases along the distal border of the ramus. Between the bases of the two more proximal setae is a small protuberance terminating in a filamentous wisp of a setule. This structure seems to be the rudiment of a fourth seta.

The pentamerous maxilla (fig. 7,*f*) is a notably slender one so that it forms in outline an elongated triangle. The medial margin of the basal segment is produced into four setiferous endites. The proximal endite bears three setae, their bases transversely inserted in a close-spaced row. The second endite bears one seta. The third endite bears two equal setae. The fourth endite is well developed, exhibiting a subquadrate outline. Terminally inserted on it are two long, subequal setae. The second segment is produced distally and medially as an endite. The armature of this consists of a long seta and a more rigid, curved, tapering spine. The spine is of about the same diameter as the seta, but shorter, and it is somewhat more heavily sclerotized. The third segment is subquadrate in outline. Inserted at the distal medial corner is a single long seta. The fourth segment is nearly twice as long as wide, with nearly parallel margins except for a slight distal medial projection furnishing insertion for a single long seta. The terminal segment is the smallest. It bears four setae. The smallest seta is inserted proximally near the medial margin. Three subequal setae are inserted apically.

The bimerous maxilliped (fig. 7,*g*) is a flattened, short, stout appendage. The basal segment is as long as wide with parallel margins. The distal medial border forms a semicircular curve. Two groups of setae are inserted medially. The basal group consists of three setae inserted on the margin and a fourth with the articulation removed a short distance laterally to the surface of the segment. The distal group consists of four setae arranged in a row around the distal medial curve. A fifth seta is inserted on the surface of the segment just proximal to the ultimate seta of the row. The second segment is a stout truncated cone, articulated diagonally on the distal lateral corner of the basal segment. There are two long setae inserted apically on the second segment. A tuft of very fine but long cilia projects medially from the basal third of the inner margin of the second segment.

Swimming legs: The first leg (fig. 7,*h*) consists of a bimerous protopodite and trimerous rami. A well-developed intercoxal plate yokes the coxopodites. Inserted at the distal medial corner of the coxa is a long seta which extends to the midpoint of the distal segment of the endopodite. The lateral marginal seta, usually found on the basipodite of related species, is here lacking. Articulated on a strongly projecting base formed by the lateral distal corner of the basipodite is a stout tapered spine which reaches to the proximal fourth of the second segment of the endopodite. The basal segment of the exopodite bears a long, stout, tapered lateral spine and a long medial seta. The second segment bears a lateral spine of about half the dimensions of that of the first segment and a medial seta. The third segment bears three nearly equal lateral spines, slightly larger than that of the second segment, an apical spine, approaching in dimensions that of the first segment, an apical seta, and three lateral setae.

The two proximal segments of the endopodite each bear a medial seta. The distal segment bears three medial setae, two apical setae, and a lateral seta inserted in an emargination just distal to the midpoint of the edge of the segment.

The protopodites of the second legs (fig. 7,*i*) are yoked by a much-reduced intercoxal plate. The coxopodites are elongated so the length of each is about equal to the width. Inserted on the distal medial corner of each coxa is a slender seta extending to the proximal sixth of the second segment of the bimerous endopodite. Inserted at the short lateral margin of the basipodite is a much-reduced filamentous setule.

All the elements of the armature of the trimerous exopodite are of setiform construction. All the lateral setae, the apical setae, and the two most distal medial setae lack plumose ciliation. The basal two segments bear each one lateral and one medial seta. The distal segment bears three lateral setae, two apical setae, and four medial setae. All the segments of the exopodite are markedly broadened, and also inflated. This tendency is progressively increased in the posterior legs.

The endopodite is bimerous but with strong indication of suppressed subdivision of the elongate distal segment. The proximal segment bears a single medial seta. The second segment bears five medial setae, two apical setae, and a lateral seta inserted at the distal third of the margin of the segment. Long spinules form rows on both segments of the endopodite and finer spinules furnish additional ornamentation at the bases of the lateral setae of both rami.

The third legs (fig. 7,*j*) each consist of a bimerous protopodite, trimerous exopodite, and bimerous endopodite. All the elements of the armature are setiform. The usual intercoxal plate is reduced to a

vestige. Inserted on the distal medial margin of the coxopodite is a slender seta which extends to the proximal tenth of the second segment of the endopodite. The lateral marginal seta of the basipodite is reduced to a minute thread.

Each of the two proximal segments of the exopodite bears a short lateral seta and a medial seta. The distal segment bears three lateral setae, two apical setae, and four medial setae. All the segments of the exopodite are broadened and inflated. The basal segment is longest, nearly equaling the combined extent of the distal segments.

The proximal segment of the endopodite bears a single medial seta. The second segment bears five medial setae, two apical setae, and a lateral seta inserted at the distal third of the margin of the segment. A curved row of stout spinules ornaments the distal lateral corner of the first segment. A parallel row starts on the lateral margin of the second segment at the proximal one-third and continues on over the surface of the segment for half its width.

The fourth legs (fig. 7,*k*) each consist of a bimerous protopodite, trimerous exopodite, and bimerous endopodite. All the elements of the armature consist of setae, several of them of markedly reduced proportions.

The segments of the protopodite are elongate and the articulation between them is displaced to run diagonally. The intercoxal plate is reduced to a vestige. Inserted on the distal medial corner of each coxa is a much-reduced seta which extends only just beyond the midpoint of the sinuate medial margin of the basipodite. The lateral marginal seta of the basipodite is reduced to a slender but elongate cilium.

The segments of the exopodite are broadened and much inflated. The basal segment is about equal to the combined extents of the two distal segments. The first segment bears only a short lateral seta. The second segment bears a similarly reduced lateral seta and a medial seta. The third segment bears two lateral setae, two apical setae, and five medial setae. Only the seta of the second segment and the proximal medial seta of the third segment are furnished with plumose ciliation.

The first segment of the endopodite bears a much-reduced medial seta, which is about as long as the segment. The second segment bears four medial setae, two apical setae, and a seta inserted at the distal third of the lateral margin. The proximal medial seta is much reduced, only slightly exceeding in length the seta of the basal segment. A row of stout spinules is set along the distal lateral corner of the basal segment. A second parallel row starts on the lateral margin of the distal segment at its proximal third and continues over the surface of the segment for half its width.

Vestigial legs and caudal rami: The bimerous fifth legs (fig. 7,*l*) are very large. The tip of each reaches to the proximal sixth of the second urosomal segment posterior to that bearing the legs. The basal segment is wide and thick, tapering inward somewhat apically. On the distal medial corner there is a short row of a few stout, elongate spinules. There is no lateral seta.

The second segment is 2½ times as long as wide, the slight distal taper being provided mainly by the curving lateral margin. There is a slender seta apically inserted, and slightly subterminal on the segment at the distal point of the linear inner margin there is a shorter, stouter, curved seta. Five or six fine spinous projections of the integument are regularly arranged along the medial margins. The distal spinule is at the base of the medial articulated spine and constitutes the medialmost of a short row of five to six fine spinules inserted on the surface of the segment. A long row of extremely fine spinules ornaments the surface of the segment at about the proximal third.

The caudal rami (fig. 7,*m*) are very short and stout, the length equaling the greatest width. They taper regularly but slightly to the distal sixth, then terminate in a smoothly curved apex. There is no ornamentation. There is a slight ventral subapical prominence of the integument forming a toelike protrusion.

Male: The sexual dimorphism of this species is of a relatively undeveloped grade. The antennule is somewhat slenderer in the male than in the female. The swimming legs of the male are more generalized in structure and the posterior exopodites lack the marked inflation seen in those of the female. The armature of the legs of the male is much less specialized. The usual sixth legs are present as bisetiferous lobes of the seventh thoracic somite.

### *Doropygus hummi*, new species

FIGURE 8

TYPES: Holotypic female, USNM 92793 (type locality, Gulf of Mexico, off Apalachicola, Fla., in unidentified ascidian); allotypic male, No. 92794, and paratypes listed below.

SPECIMENS EXAMINED:

FLORIDA

From unidentified solitary ascidian:

Gulf of Mexico, off Apalachicola, lat. 28°45′ N., long. 85°02′ W., dredged in 30 fms., Mar. 15, 1885, *Albatross* Station 2405, holotypic female, allotypic male, 30 female paratypes.

Gulf of Mexico, 3½ miles southwest of Longboat Pass, Sarasota Bay, dredged in 5–6 fms., Mar. 24, 1951, J. B. Knight, 40-plus females.

DESCRIPTION: Female (fig. 8,*a–m*): General features: This is a minute species of *Doropygus*. The body, however, presents the usual

aspect (fig. 8,*a*) of 5-segmented metasome and 6-segmented urosome. The brood sack is not an exaggerated feature in this form and, since the eggs are relatively enormous, accommodates very few of them, generally less than 10. Instead of presenting the usually conspicuous epimera, the head and thoracic segments are inflated laterally, so that the appearance, viewed from above, is of a series of bulges of varying dimensions. The head is produced ventrally at the apex as a conspicuously developed rostrum.

Head appendages: The 9-segmented antennule (fig. 8,*b*) is much enlarged basally with a long, slender, tapering terminal portion. The two proximal segments are massive and of about equal width. Segments 3 through 6 participate in a fairly uniform taper and the elongate three terminal segments are about equal in width. The setation is profuse and the setae are fairly long and slender, mostly with well-developed ciliation. Particularly elongate setae are inserted on the sixth and ninth segments.

The three segments of the antenna (fig. 8,*c*) are unequal. The basal segment is the longest, nearly three times as long as wide and of fairly uniform width. The second segment is less than half as long as the first, about as wide. Its medial margin bows slightly outward in a gentle curve. The terminal segment is relatively short, about twice as long as its greatest width. The lateral margin is roughly linear. The medial margin tapers outward to the distal fourth then is constricted inward to the apex. A stout curved claw is apically inserted, and is accompanied by a slender seta.

The coxopodite of the mandible is expanded medially as a flattened masticatory plate. The basipodite (fig. 8,*d*) is compact. It bears a single medial seta, inserted at the distal fourth of the inner margin. The medial two-thirds of the distal extent of the basipodite affords articulation for the bimerous endopodite. The first segment of the endopodite bears three subequal setae arranged in a distal medial row. Nine setae of varying dimensions are arranged along the medial and distal margins of the second segment.

The exopodite is narrow and elongate. Five long, slender, subequal setae are arranged in a compact diagonal row along the terminal third of the ramus. Segmentation is suppressed.

The basal portion of the maxillule (fig. 8,*e*) is expanded medially as the proximal endite, along the medial margin of which are arranged eight masticatory setae. A tapered setiform structure is inserted on a more distal slight prominence representing the second endite. The epipodite is a reduced lateral protuberance bearing a long proximal seta and a distal reduced setule. The basipodite bears three long subequal setae, distally directed. The subequal endopodite and exopodite each bear three setae inserted distally.

The maxilla (fig. 8,*f*) is pentamerous with each segment produced medially in one or more setiferous protuberances. The four protuberances of the proximal segment bear respectively three, one, two, and two setae each. The second segment bears two subequal setae, the more distal only three-fourths as long as the other. The third and fourth segments bear one seta each. The fifth segment bears two subequal medially directed setae and a smaller apical seta.

The maxilliped (fig. 8,*g*) is obscurely bimerous. The bulk of the appendage is a subrectangular flattened plate. Along the medial margin seven setae are arranged as a more proximal pair and distal quintet. At the distal lateral corner a slight protuberance representing the second segment bears two long slender setae. The medial margin of the protuberance bears a row of fine hairlike cilia.

Swimming legs: The protopodites of the first swimming legs (fig. 8,*h*) are connected by a well-developed intercoxal plate. Each coxa bears at the distal medial corner a long well-developed seta which extends beyond the tip of the endopodite. On a distal medial prolongation of the basipodite is set a long, stout spine. It reaches to just beyond the proximal margin of the terminal segment of the endopodite. There is a reduced seta borne just medial to the short lateral margin of the basis.

The three segments of the exopodite are more or less equivalent in size. The proximal segment is largest, the second is smallest. There are a lateral spine and medial seta borne on each of the two more proximal segments. The terminal segment bears three lateral marginal spines, a terminal spine and seta, and three medial marginal setae. The spine of the basal segment is the stoutest spine and its length about equals that of the apical spine. The remaining spines are subequal and very little smaller.

The trimerous endopodite is armed only with setae; one on the basal segment, one on the second segment, and six on the terminal segment. Of these six, three are lateral, one is apical, one subterminal laterally, and one is inserted in an emargination of the lateral margin which is at about the proximal third of the length of that margin.

A very reduced intercoxal plate connects the protopodites of the second swimming legs (fig. 8,*i*). There is a well-developed seta at the distal medial corner of the coxa extending much beyond the tip of the endopodite. There is a reduced, fine seta borne laterally on the basipodite. The ornamentation of the rami consists entirely of setiform elements. The two proximal segments of the trimerous exopodite bear each a lateral seta and a medial seta. The terminal segment has three marginal lateral setae, two terminal setae, and four setae arranged along the medial margin.

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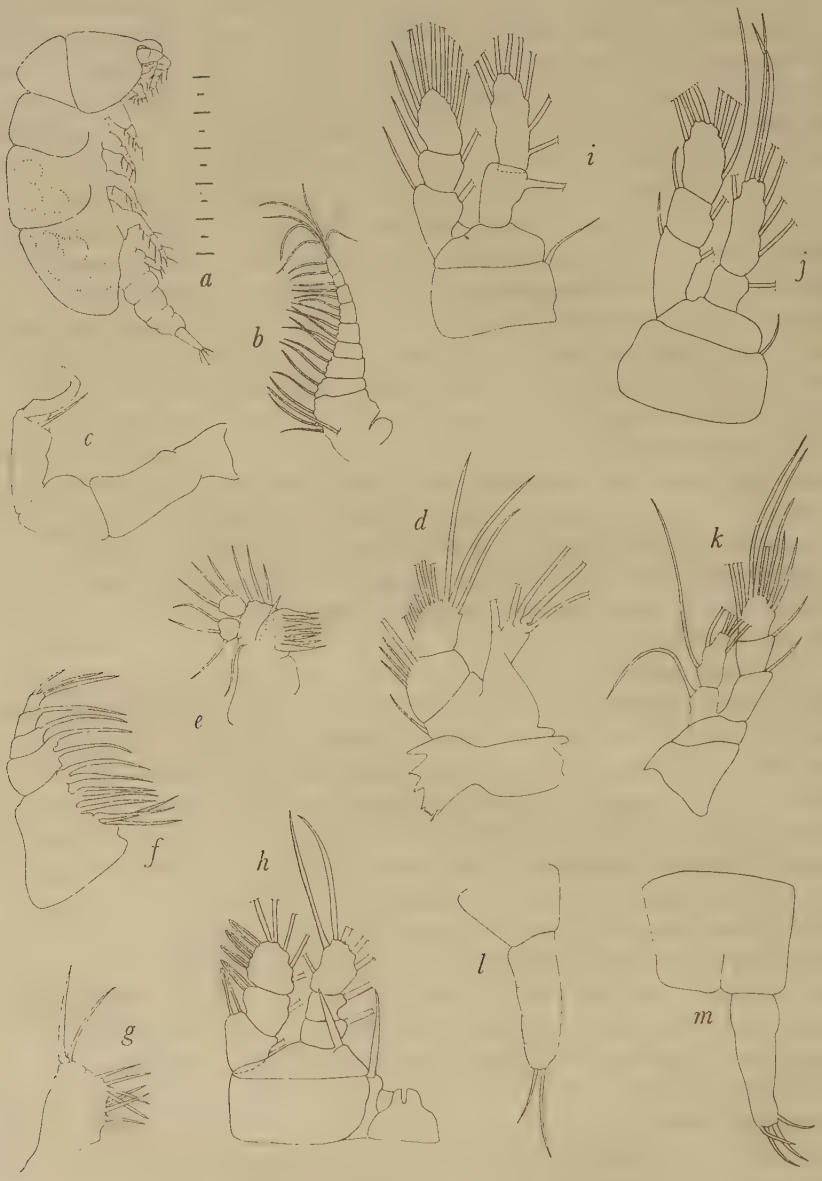


FIGURE 8.—*Doropygus hummi*, new species, female: *a*, habit, lateral view; *b*, antennule; *c*, antenna; *d*, mandible; *e*, maxillule; *f*, maxilla; *g*, maxilliped; *h*, first leg; *i*, second leg; *j*, third leg; *k*, fourth leg; *l*, fifth leg; *m*, caudal ramus. The scale, referring to *a*, represents 0.5 mm.

The proximal segment of the bimerous endopodite bears a single medial seta. Four setae are arranged along the medial margin of the terminal segment, two setae are apical, one seta is just subapical laterally, and one seta is set in an emargination at the distal third of the lateral margin of the segment. The endopodite is an unusually small one.

The protopodite of the third leg (fig. 8,*j*) consists of two subequal segments, basipodite and coxopodite. The coxas are yoked by a somewhat reduced intercoxal plate. A very elongate seta is inserted at the distal medial corner of each coxa. There is a reduced seta inserted near the lateral margin on the basipodite.

The exopodite is trimerous. All elements of the armature are setiform. The proximal two segments each bear a lateral seta and medial seta. The terminal segment bears three lateral marginal setae, two terminal setae, and four setae arranged along the medial margin.

The proximal segment of the reduced bimerous endopodite bears a single medial seta. The distal segment bears four setae arranged along the medial margin, two apical setae, a subapical lateral seta, and one seta inserted in an emargination at the distal third of the lateral margin.

The coxopodites of the fourth legs (fig. 8,*k*) are yoked by an almost obsolete intercoxal plate. At the distal medial corner of each coxa is inserted a seta which extends just beyond the midpoint of the distal segment of the endopodite. There is a reduced seta inserted near the lateral margin of the basipodite.

All the elements of the armature of the trimerous exopodite are setiform. The proximal segment bears a lateral seta and the medial seta may be present or absent. The second segment bears a lateral and medial seta. The terminal segment bears two setae on the lateral margin, two apical setae, and four medial setae.

The bimerous endopodite reaches only to the terminal segment of the short exopodite. The basal segment bears one medial seta. The distal segment bears six setae, two on the medial margin, two apical, one subapical laterally, and one inserted in an emargination at the distal third of the lateral margin.

Vestigial legs and caudal rami: The large fifth leg (fig. 8,*l*) is bimerous. The basal segment is relatively small, subrectangular, about half again as broad as long. A small seta is inserted in the distal lateral corner. The width of the terminal segment is two-thirds that of the basal. It is 3½ times as long as its basal width and tapered slightly to the rounded apex. Two subequal setae are subapically inserted. The medial seta is stouter and somewhat spiniform. Fine spinules form several short rows along the medial margin.

The caudal ramus (fig. 8,*m*) is relatively stocky. The length is slightly less than four times the basal width. There is a considerable taper distally. Four long, subequal setae are apically inserted. The length of the longest is nearly twice the basal width of the ramus. A fifth seta is inserted on the lateral margin just beyond the proximal fourth of its length.

Male: The male is of minute size. In most features there is general conformity in structure to the female, except for the presence of the sixth legs on the genital somite.

Remarks: This species seems to be very closely related to *D. laticornis*. In most of the features of segmentation and ornamentation it conforms rather well to the latter. However, its minute size, most distinctive proportions of appendages, and reduced setation of the swimming legs furnish ample characters for satisfactory separation from the notably variable earlier species.

### *Doropygus mohri*, new species

Figure 9

Types: Holotypic female, USNM 92814 (type locality, Puget Sound, Washington, in *Styela gibbsii* (Stimpson)); allotypic male, No. 92815, and paratypes listed below.

Specimens examined:

Washington
From *S. gibbsii:*
Puget Sound, 1895, holotypic female, allotypic male.
East of Upright Head, dredged in 25–35 fms, June 23, 1950, 1 female.

Description: Female (fig. 9,*a–v*): General features: This rarely encountered form is a distinctly characterized one nonetheless. It is a relatively large representative among the Western American species. The body (fig. 9,*a*) is that of a robust generalized *Doropygus*. The metasome is 5-segmented, the urosome is 6-segmented. The head terminates apically in a conspicuous rostrum.

Head appendages: The antennule (fig. 9,*b*) is 9-segmented. The two basal segments are much inflated. There is a considerable diminution in measurement from the second segment to the third. There is a very sharp taper through the third through sixth segments. The terminal four segments taper gradually. The apical segment is about as long as wide. The setae are fairly well developed, but sparsely or obsoletely plumose. They are concentrated along an outer setiferous margin. The basal segment has two long stout setae at the outer distal corner, these accompanied by one or two minor setae. The second segment bears the greatest number of setae, 10 or more. Third, fourth, and fifth segments bear a small number of setae. The sixth segment is distinctive for the very long and well-developed seta

inserted at the distal outer corner. The seventh and eighth segments have few setae. The terminal segment is ornamented with six or more setae which tend in their arrangement to concentrate in an apical radiating tuft.

The antenna (fig. 9,*c*) is trimerous, with the basal segment the longest. The posture of the limb is in a characteristic right-angled flexure. At the distal corner of the basal segment internal to the flexure are inserted two minute but distinct setules. The length of the second segment but slightly exceeds its width. The segment is slightly but not markedly narrower than the first. The terminal segment is the narrowest. Inserted on the distal end in a complicated articulation is a curved stout tapered hook. Three setae are set on the distal end of the segment close to the articulation of the hook. Three setae form a compact cluster appressed on the surface of the segment at a level about a third of the length of the segment proximal to the articulation of the hook. Proximal still another third is the outer marginal insertion of a single reduced setule.

The mandible consists of a 2-segmented protopodite, a bimerous endopodite, and a tetramerous exopodite. The coxopodite is extended medially as the usual masticatory plate featured by a serrate inner margin (fig. 9,*d*). The basipodite (fig. 9,*e*) is a large segment. Near its distal medial corner is inserted a single seta. The medial half of the terminal margin of the segment is produced to form a wide articulation with the bimerous endopodite. Around the distal medial corner of the proximal segment of the endopodite is inserted a row of four setae. These are graduated markedly from a small proximal seta to an elongate distal seta. Forming a row around the distal two-thirds of the medial margin and the whole of the truncate apical border of the terminal segment are nine graduated setae. Six of these form a close-spaced row. Three have their bases closely associated on a slight distolateral prominence of the segment.

The exopodite is conspicuous, long and tapered from a broad insertion on the basipodite to a narrow apex. Each of the three proximal segments bears a long stout seta inserted at the distal medial corner. The minute apical segment bears two subequal setae terminally placed.

The maxillule (fig. 9,*f*) is characterized by a marked tendency to obliteration of obvious segmentation. The protopodite is obscurely 2-segmented. The basal portion supports two endites and a reduced epipodite. The proximal endite is expanded and conspicuous. Distally along its medial margin is inserted a row of nine setae, predominantly stout and sharply tapered, although two are slender. Just distal to this principal endite is a small projection terminating in a setiform elongation which is considered to represent a second endite.

The epipodite is represented by a long tapered seta accompanied by a minute accessory setule.

The terminal mass of the protopodite, equivalent to the basipodite, bears a medially directed distal row of three setae. Somewhat laterally oriented on the apex of the protopodite are the two reduced rami, each bearing three setae. The setae of the endopodite are inserted respectively apically and upon two emarginations of the medial border arranged in uniform step-formation. The setae of the exopodite radiate fan-wise from closely set bases along the truncate distal margin.

The maxilla (fig. 9,*g*) is pentamerous. The principal mass of the appendage consists of the basal segment which bears four setiferous prominences representing endites. The basal endite bears three setae. The second endite is represented by a single seta inserted on a very slight prominence. The third endite bears two equal setae. The fourth endite is the longest. It forms a well-demarcated quadrate mass bearing three setae. Two of these are well developed, of about equal proportions, inserted apically. Just proximal to these is set a reduced setule.

The second segment is much wider than long. Distally this segment extends in a medial prolongation which constitutes a stout, heavily sclerotized hook, about two-thirds as long as the principal setae of the maxilla. Inserted at the base of the hook are one well-developed long seta and an accessory reduced setule.

The two next distal segments are subequal in proportion with a well-discernible apical taper. Inserted prominently at the distal medial corner of each of these segments is a single long seta. The reduced terminal segment bears four setae. Three of these are subequal and their bases are close-set in an apical insertion. The fourth is the smallest and is inserted on the surface of the segment toward the basal articulation.

The bimerous maxiliped (fig. 9,*h*) is elongate and relatively slender. The medial margin bears nine setae arranged in two groups. The proximal set of setae consists of four. The distal five setae are close-set around the curved distal medial margin. Articulated subapically and far laterally is the much-reduced distal segment. It constitutes little more than an insertion for two long, approximately equally developed setae.

Swimming legs: The protopodites of the first legs (fig. 9,*i*) are conspicuously bimerous; the rami are trimerous. The coxopodites, yoked by a triangular, apically bilobed intercoxal plate, are of rectangular outline. At the medial distal corner of each coxa is inserted a long tapering seta, the tip of which reaches just beyond the distal border of the endopodite. The basipodite has a very short lateral

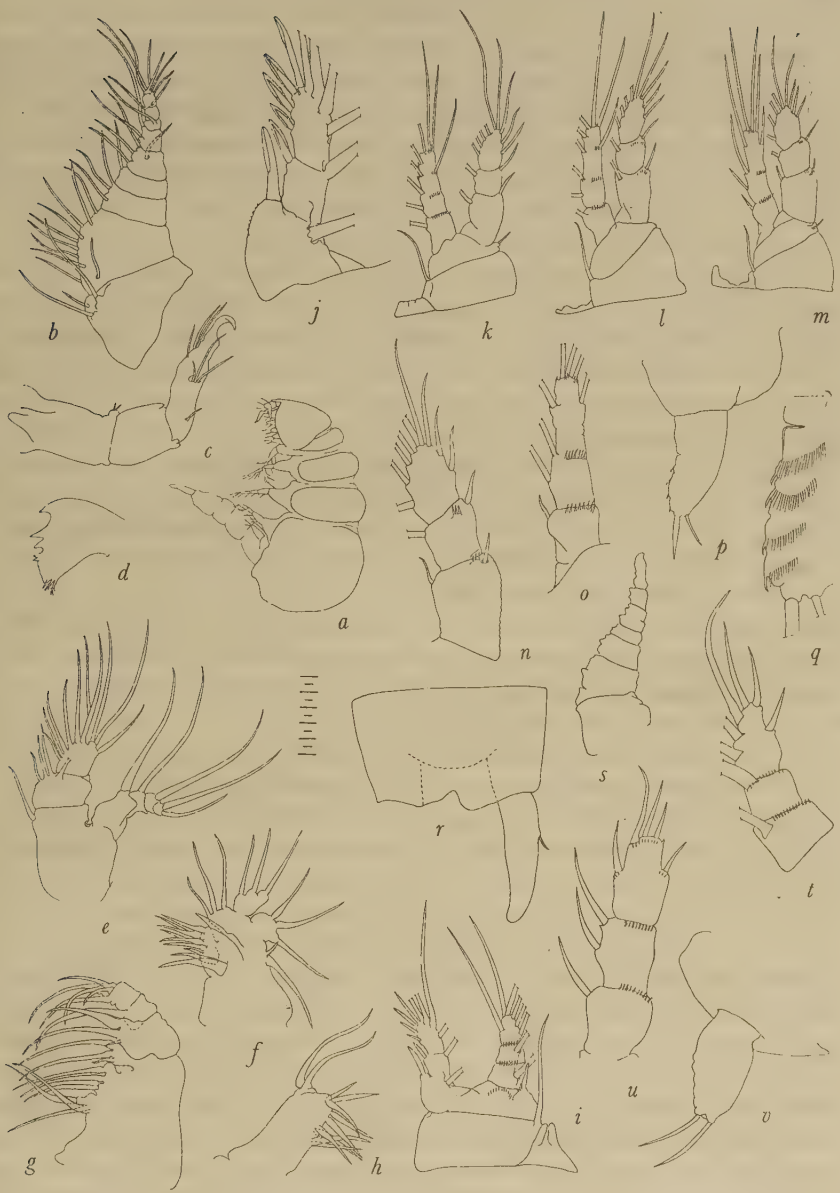


FIGURE 9.—*Doropygus mohri*, new species. *a–r*, Female: *a*, habit, lateral view; *b*, antennule; *c*, antenna; *d*, masticatory lamella of mandible; *e*, palp of mandible; *f*, maxillule; *g*, maxilla; *h*, maxilliped; *i*, first leg; *j*, exopodite of first leg; *k*, second leg; *l*, third leg; *m*, fourth leg; *n*, exopodite of fourth leg; *o*, endopodite of fourth leg; *p*, fifth leg; *q*, medial ornamentation of fifth leg; *r*, caudal ramus. *s–v*, Male: *s*, antennule; *t*, endopodite of first leg; *y*, endopodite of fourth leg; *v*, fifth leg. The scale, referring to *a*, represents 1.0 mm.

margin and a long diagonal articulation with the exopodite; the rest of the distal border is roughly parallel with that of the coxa. A reduced seta is inserted near the lateral margin. At the medial distal corner of the basis is articulated a well-developed tapering spine which reaches just beyond the distal border of the basal segment of the endopodite. A curved row of spinules constitute an ornamentation of the basis near the articulation of the endopodite. There are also a few spinules inserted near the base of the medial spine.

The segments of the exopodite (fig. 9,*j*) are subequal. The basal is the widest and each of the succeeding segments diminishes somewhat in width. The distal segment is longest. Each of the two basal segments bears a stout lateral spine and an elongate medial seta. Inserted on the terminal segment are three spines along the lateral margin, an apical outer spine and inner seta, and three setae along the medial border. The spine of the basal segment is the stoutest and longest. All the others are of about equal thickness. The apical spine is just slightly shorter than the basal one. The proximal spine of the third segment is the shortest. All the spines have partial or extensive transparent serrated marginal flanges.

The two proximal segments of the endopodite bear each a medial seta. The terminal segment bears three medial marginal setae, two apical setae, and a seta inserted in an emargination at about the midpoint of the lateral margin.

The second legs (fig. 9,*k*) show the initial stages of tendencies progressively developed in the succeeding two pairs of legs. The articulation of coxopodite and basipodite is somewhat diagonal so that the lateral margin of the coxa is longer than the medial margin. There is a uniting intercoxal plate, but the distal extent of this is only to about the midpoint of the medial margin of the coxa and the plate is weakly sclerotized. There is inserted on the medial distal corner of the coxa a well-developed seta which extends to a point just slightly beyond the distal border of the basal segment of the endopodite. Inserted near the short lateral margin of the basipodite is a very reduced seta.

The exopodite is trimerous. Its armature consists of the usual lateral spines and medial setae. However, the distal elements in the usual position of spines are of markedly setiform construction. There is a short slender lateral spine and a well-developed medial seta borne on each of the two proximal segments. On the distal segment there are three laterally inserted elements graduated from an elongate spiniform proximal member to a distal element approximating a seta in proportions. There are two apical setae, the lateral one much shorter and presumably representing a modified spine. Inserted along the medial border are four well-developed setae.

The endopodite is bimerous, with the elongate distal section pre-

serving traces of a fundamental segmentation. The basal segment bears one medial seta. The elongate distal segment tapers apically. It bears five marginal medial setae, two apical setae, and a single seta inserted in an emargination removed proximally about one-third the length of the segment from the apex. A short row of spinules curves across the face of the segment at the level of the second medial seta. There are also spinules at the base of the lateral and apical setae and a row of spinules on the lateral distal border of the basal segment.

The line of articulation of the coxopodite and basipodite of the third legs (fig. 9,*l*) is markedly diagonal. The medial proximal corners of the coxopodites are yoked by a rudimentary intercoxal plate, the length of which approximates only one-third its width. At the distal medial corner of the coxa is borne a seta which extends to the level of the insertion of the medial seta of the proximal segment of the endopodite. Inserted near the short lateral margin of the basipodite is a much-reduced setule.

The armature of the exopodite is a series of diverse setiform members, the laterally inserted elements which ordinarily would be spines having all the characteristics of short setae. The proximal two segments bear each a short lateral seta and a normal medial seta. The terminal segment bears three lateral setae, two apical setae, and four medial setae. The two proximal lateral setae are short and of dimensions similar to those of the basal segments.

The endopodite is bimerous. The basal segment bears a single medial seta. The distal segment, elongate, slightly tapered, and with vague indications of fundamental subdivision, bears five medial setae, two apical setae, and one lateral seta. Further ornamentation of the rami is provided by short rows of fine spinules.

The protopodites of the fourth legs (fig. 9,*m*) are produced. The line of articulation of the coxopodite and basipodite is diagonal so that the outer margin of the coxopodite is about double the length of the medial margin. The coxopodites are yoked by an intercoxal plate. This is conspicuously reduced but the outer margins are coextensive with the medial margins of the coxa. Inserted on the distal medial corner of the coxopodite is a slender seta which extends to about the midpoint of the proximal segment of the endopodite. Near the short lateral margin of the basipodite is inserted a much-reduced setule.

The armature of the trimerous exopodite (fig. 9,*n*) consists of mostly normal setae and, on the outer margins of the segments, elements which approach somewhat more spiniform construction than the corresponding setiform members of the other swimming legs.

The basal segment is elongate. It bears a short lateral spine and a very short medial seta which scarcely exceeds the spine in length. The second segment bears a lateral spine and a medial seta. The

terminal segment bears three lateral spines, considerably tending toward setiform aspect, an apical spine which closely approximates setiform proportions, an apical seta, and four setae disposed along the medial border.

The endopodite (fig. 9,*o*) is bimerous, but with the elongate second segment preserving traces of the fundamental subdivision into two podomeres. The basal segment bears a very short, reduced medial seta. The distal segment bears four setae arranged along the medial margin, two apical setae, and a lateral seta inserted in an emargination of the border of the segment opposite the insertion of the third medial seta. The lateral seta and the two more proximal setae of the distal segment are considerably reduced. A row of fine spinules ornaments the distal border of the basal segment of the endopodite and a second row curves over the surface of the distal segment at the level of the second seta. A few spinules are set at the insertions of the lateral setae of the endopodite and of the spines of the exopodite.

Vestigial legs and caudal rami: The bimerous fifth legs (fig. 9,*p*) are of reduced absolute dimensions. The basal segment is half again as wide as long and lacks ornamentation. The distal segment is 2½ times as long as its basal width. The margins are roughly parallel for slightly more than half the length, then there is a taper to the somewhat narrowed apex. The armature consists of two apically inserted elements, the more medial spiniform; the lateral a reduced seta. Along the medial side there are four projections (fig. 9,*q*) interrupting the margins. These constitute elaborations of the integument related to rows of fine spinules. Each row of spinules extends a considerable distance laterally over the surface of the segment. The spinules are fine-textured, closely appressed to the segment, and not readily obvious.

The caudal rami (fig. 9,*r*) are long, their length about six times the greatest width. The margins are nearly parallel for about one-third of the length where a distinct emargination provides insertion for a short seta. From the seta distally the ramus tapers gradually and curves slightly inward, terminating in a curved apex narrowed to about one-third of the basal width. There is no apical armature.

Male (fig. 9, *s–v*): There is a relatively strong sexual dimorphism shown in the appendages of this species for a representative of *Doropygus*. The antennule (fig. 9,*s*) retains weak indications of an obsolete prehensile function, particularly in the coalescence of terminal segments. The swimming legs are not so elongate and the armature is much reduced in length and markedly spinose (fig. 9,*t*,*u*). The fifth leg (fig. 9,*v*) is a much less elaborate structure than that in the female, with simplified outline and reduced ornamentation. The sixth legs are of the generalized type.

### *Doropygus profundus*, new species

FIGURE 10

TYPES: Holotypic female, USNM 92801 (type locality, off San Nicolas Island, Calif., in *Bathypera ovoidia* (Ritter)); allotypic male, USNM 92829, paratypes listed below.

SPECIMENS EXAMINED:

CALIFORNIA

From *B. ovoidia:*

Off San Nicolas Island, dredged in 1,084–1,100 fms., Apr. 13, 1904, *Albatross* Station 4425, holotypic female, allotypic male, 4 female and 4 male paratypes.

DESCRIPTION: Female (fig. 10,*a–n*): General features: The body (fig. 10,*a*) is a comparatively slender one. In the long-preserved material studied the brood sack is prolonged posteriorly as a tubular structure. Whether this is an artificiality related to the collection of the host from a great depth and long preservation before removal of the copepod is not obvious. The usual body segments are all neatly delimited, and the appendages are trim and symmetrically disposed. The anteriormost portion of the head is produced ventrally as the well-developed rostrum.

Head appendages: The antennule (fig. 10,*b*) is 9-segmented, with fairly well-developed setation. The two basal segments are the longest and by far the stoutest. The appendage forms an inflection at the joint between the fifth and sixth segments. A sharp taper brings a graduated reduction of the mass of the proximal segments so that the diameter of the fifth segment is only a fourth or less of that of the first segment. The diameter of the distal four segments is subequal and the major differentiation of these in dimension is the variety of lengths. The sixth segment is the longest of the terminal four, succeeded in rank of length by segments nine, eight, and seven. No seta of the appendage is particularly long, but the general armature is a well-developed one for a species of *Doropygus*.

The 3-segmented antenna (fig 10,*c*) is slender. The basal segment is the longest and is relatively slim and linear, with a slight distal flare. The apex of the flare provides an insertion for two reduced setae, which are extremely well developed for a *Doropygus*. The longer is about double the dimensions of the lesser one and its length is about equal to the diameter of the segment at its longitudinal midpoint. The second segment is relatively long, although it is the shortest segment of the appendage. The outer margin is linear, the inner is produced in a markedly subsemicircular convexity. Subterminally on the outer margin is set a reduced seta. The distal segment is long and slender, the length approximating four times the

greatest width. The outer margin is linear, the inner somewhat sinuate. The terminal articulated hook is a relatively slender one. The setal armature includes six apical and slightly subterminal setae, a trio of graduated setae inserted on the surface of the segment about a third of its length proximal from the tip, and a reduced seta articulated near the outer margin at about a quarter of the length of the segment from its base.

The mandible (fig. 10,*d*) consists of a 2-segmented protopodite and well-developed rami. The coxa is produced medially as the masticatory process. The basipodite is relatively short, and its armature consists of a single well-developed seta inserted subterminally on the medial margin. The articulation of the endopodite is apical. This ramus is 2-segmented, the segments subequal and relatively large. The basal segment bears a row of graduated setae closely spaced and inserted at the medial distal corner. A complement of 10 graduated setae form a marginal row, closely spaced, applied to the medial and apical margins of the distal segment. This row starts at a point on the medial margin about a fourth of the length of the segment distal from its articulation and extends around to the distal lateral corner of the subquadrate segment.

The exopodite articulates with a wide emargination extending along the distal half of the lateral rim of the basis. The exopodite is well-developed, fairly long, and tapered from a wide base. It is 4-segmented. The armature consists of five well-developed setae, one inserted on each of the more proximal segments and two of the ultimate segment. All the setae of the mandible are plumose.

The protopodite of the maxillule (fig. 10,*e*) shows a considerable degree of coalescence, with no clear indication of the fundamental plan of its segmentation. The proximal endite is the usual flaring lobe set with a masticatory row of eight setae of varying dimensions. A second endite is represented by a narrowly triangular process extending along the apex of the proximal endite. The epipodite is a slight prominence bearing a well-developed principal seta accompanied by a rudimentary auxiliary seta. The plane of coalescence of the coxal portion of the protopodite with the basis is displaced to proceed almost longitudinally. The three subequal setae assignable to the basipodite are inserted in a row along a truncate margin which is the distal boundary of the protopodite. The result of alteration of orientation is that both endopodite and exopodite are directed laterally. The endopodite bears three setae. The exopodite has three setae well developed, with an articulated fine setule which is the obvious vestige of a fourth seta.

The maxilla (fig. 10,*f*) is pentamerous. The protopodite is a single segment bearing four endites. The proximal endite is armed with

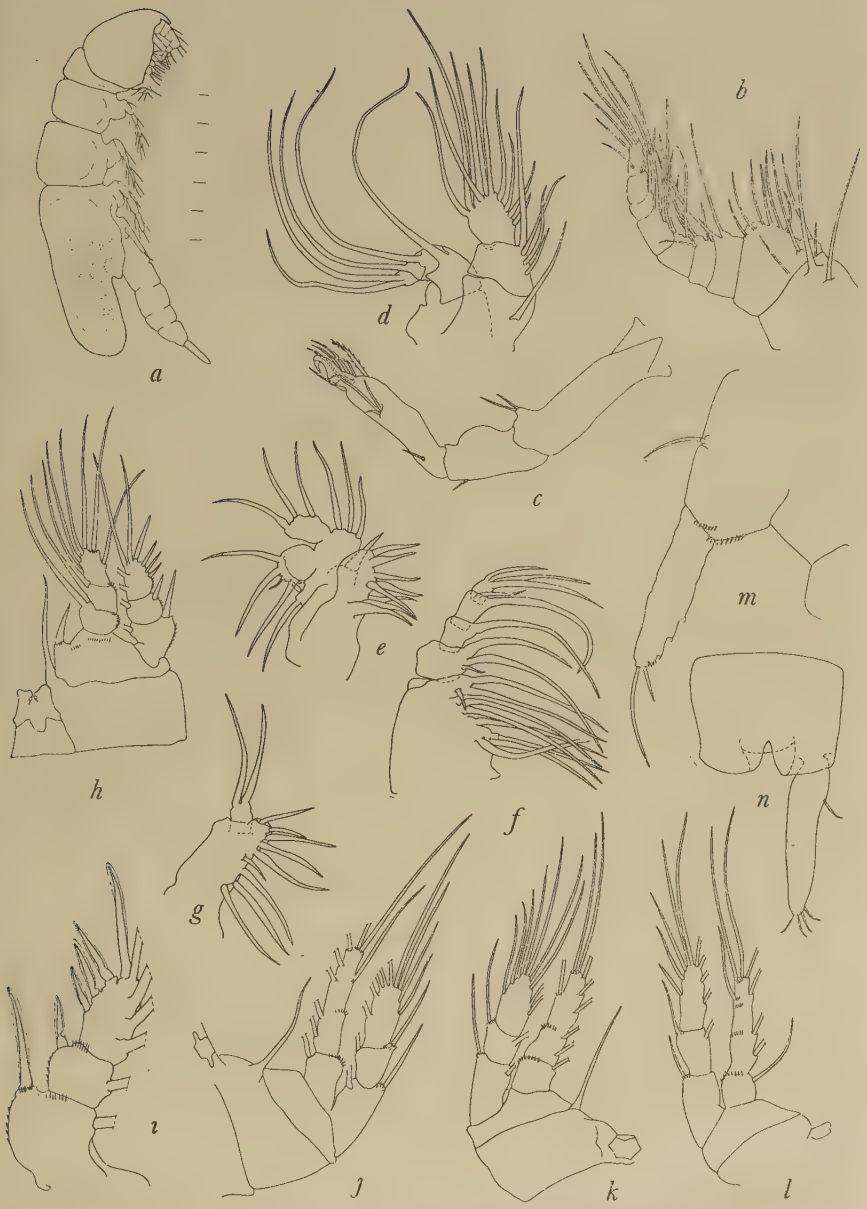


FIGURE 10.—*Doropygus profundus*, new species, female: *a*, habit, lateral view; *b*, antennule; *c*, antenna; *d*, palp of mandible; *e*, maxillule; *f*, maxilla; *g*, maxilliped; *h*, first leg; *i*, exopodite of first leg; *j*, second leg; *k*, third leg; *l*, fourth leg; *m*, fifth leg; *n*, caudal ramus. The scale, referring to *a*, represents 1.0 mm.

three setae, arranged in a characteristic row along a line at right angles to the axis of the appendage. The second endite has a single seta; the third endite bears a pair of equal setae; the fourth endite is the most produced and prominent and bears two subequal setae accompanied by a basal vestigial setule. The second segment bears two subequal setae and a vestigial setule. The distal seta is shorter and more rigid than its companion. It is the homologue of the heavy claw-process of other genera. The third and fourth segments bear a single seta each. The terminal segment has four setae. Three of these are apical. A reduced seta is borne on the surface of the segment just distal to the articulation.

The maxilliped (fig. 10,*g*) is bimerous. The gnathal margin bears a proximal quartet and a distal quintet of setae. The distal segment is articulated somewhat subapically and laterally on the basal segment. The armature of the distal segment consists of two long, subequal setae.

Swimming legs: In the first legs (fig. 10,*h*) the protopodites are extensive. The intercoxal plate is well developed. The coxa is ample, quadrate; it bears a medial seta which extends slightly beyond the midpoint of the distal segment of the exopodite. The distal margin of the basipodite is much indented to accommodate the articulations of the rami. The medial margin of the basipodite culminates in an expanded base supporting the usual articulated heavy spine. This spine reaches to a point at about a level with the proximal third of the second segment of the endopodite. The usual lateral seta of the basipodite is here either rudimentary or lacking. As an unusual feature of the outline of the basis there occurs a distal prolongation beyond the articulated spine to the level of articulation with the endopodite.

The major ornamentation of the trimerous exopodite (fig. 10,*i*) consists of six spines and six setae. The basal segment bears a lateral spine, nearly distally directed, and a medial seta. The second segment bears a lateral spine and medial seta. Of the four spines of the distal segment three are ranged along the lateral margin and one is apical. Of the setae, one is apical and three are inserted along the medial margin. The most basal and most distal spines are the longest and stoutest. The remaining four are subequal.

The trimerous endopodite is ornamented with a single medial seta on the basal segment, a single medial seta on the second segment, and six setae on the distal segment. The disposition of these setae is as a medial row of three, two apical and one near the midpoint of the lateral margin. The seta of the basal endopod segment is borne on a marked prolongation of the distolateral corner of the segment.

The 2-segmented protopodites of the second legs (fig. 10,*j*) are somewhat produced and extended laterally as well as distally in the sagittal plane. Most of the production is in the coxa. An intercoxal plate is present, but it is reduced and insignificant. The inner coxal seta is a highly developed one and reaches almost to the tip of the endopodite. The basis bears no readily detectable armature.

The exopodite is trimerous. All the elements of the armature exhibit the general qualities of setae, although those in positions usually occupied by spines on appendages homologous to this are somewhat differentiated from the remainder and, in the main, lack the ciliation usually occurring in setae. The basal segment bears a medial typical seta and a lateral seta which occupies the position of the usual spine. The second segment bears a lateral and a medial seta. The distal segment bears three lateral setae, two apical setae, and four medial setae.

The endopodite is bimerous with strong indication of fusion of two elements to form the distal segment. The proximal segment bears one medial seta. The armature of the distal segment is composed of five setae along the medial margin, two apical setae, and one seta set considerably subterminally on the lateral margin.

The protopodite of the third leg (fig. 10,*k*) very much resembles that in the second leg. The intercoxal plate is present, but somewhat more reduced than in the second legs. The medial coxal seta is long, extending to the level of the distal quarter of the length of the distal segment of the endopodite. The basis bears no armature.

The armature of the trimerous exopodite consists of setae and the elongate setalike modifications of the usual spines. The basal segment bears a spine on the medial distal corner and one on the lateral distal corner. The second segment is similarly ornamented. The third segment bears three setae on the lateral margin, two apical setae, and four setae along the medial margin.

The endopodite is bimerous and the distal segment is somewhat produced. The basal segment bears a single medial seta. The distal segment has a medial row of five setae, two apical setae, and one lateral seta.

The fourth legs (fig. 10,*l*) exhibit the prolongations laterally of the protopodites which occur in the two preceding pairs. The intercoxal plate is reduced to near vestigial proportions. The armature of the protopodite is either vestigial or lacking.

The exopodite is trimerous and the armature consists of slender setae. The basal segment bears a single lateral seta. Segment two has a lateral seta and a medial seta. The distal segment has three lateral setae, two apical setae, and four medial setae.

The endopodite is bimerous. The basal segment bears a single medial seta. The distal segment bears three medial setae, two apical setae, and two lateral setae.

Short rows of minute spinules ornament the bases of some of the setae and portions of the margins of the segments of all the four pairs of swimming legs.

Vestigial legs and caudal rami: The fifth legs (fig. 10,*m*) are bimerous. The proximal segments of the pair are connected by a medial sclerotized ridge suggestive of the intercoxal plates of legs 1 to 4. However, the homology of the protopodite here is not clear. The distal segment is elongate. The lateral margin is roughly linear, and the medial margin is characterized by a series of emarginations. Complications of the integumentary structure form characteristic spinulelike ornamentation of the emarginations. Two subequal setae are borne at the apex of the segment. There are a few short spinules set just subapically on the medial margin.

The length of each caudal ramus (fig. 10,*n*) is roughly 4½ times its greatest width. The margins are rather smooth and there is a gentle taper to the rounded apex. A lateral seta is set at about the proximal quarter of the length of the outer margin. There are four roughly equal apical setae. The lengths of the setae are about two-thirds the greatest width of the ramus.

Male: There is no outstanding feature in the sexual dimorphism of this species except the presence of the usual rudimentary sixth legs borne on the genital segment of the male.

Remarks: This species comes from the greatest depth so far recorded for an ascidicolous copepod.

### *Doropygus schellenbergi*, new species

Figure 11

Types: Holotypic female, USNM 92796 (type locality, off Georgia, in unidentified ascidian), and paratypes listed below.

Specimens examined:

Georgia
From ascidian:
Off Georgia, lat. 32°03′ N., long. 79°49.5′ W., dredged in 14 fms., Feb. 13, 1940, U. S. Fish and Wildlife Service Vessel *Pelican*, Station 181–13, holotypic female and 10 female paratypes.

Description: Female (fig. 11,*a–m*): General features: This is a minute species of *Doropygus*. A notable feature is the distinct sclerotization, particularly in its extension to the urosome and caudal rami. The metasome (fig. 11,*a*) is much inflated with some tendency to obscuring of the segmentation. The head is produced anteriorly and ventrally in a stout projection, forming the usual rostrum.

Head appendages: The antennule (fig. 11,*b*) is of moderate length, much greater in diameter basally than at the tip. No segment is particularly elongate. There are nine segments, of which the proximal is longest and by far the most massive. The second segment and the third approach the first in length and mass. The proximal two segments are of fairly uniform thickness and are succeeded by the third to sixth, which are sharply graduated in diameter so that the appearance has a telescope effect tapering the appendage to the terminal trimerous unit of seventh to ninth segments, which are subequal in length and fairly equal in width. The setation is relatively profuse and exhibits no differentiation of particularly distinctive elements except that the second, fourth, and fifth segments bear long, fairly robust setae.

The trimerous antenna (fig. 11,*c*) is slender and elongate, with reduced ornamentation. The basal segment forms a complicated articulation with the head and the medial margin has a slight distal expansion. The length is about four times the width at the midpoint. The articulating ends of the second segment are of the same width as the basal segment and the length is twice this. The outline of the segment is modified by the production of the middle half of the medial margin as a semicircular protuberance. The terminal segment is half again as long as the second segment. The greatest width is at the distal eighth and from this the segment tapers proximally to a width at the articulation of half that of the articulating margin of the second segment. Apically the segment tapers sharply to the articulation of the relatively slender, curved terminal hook. A slender seta is inserted at the articulation of the hook. A second seta is inserted at the distal third of the outer margin.

The basal segment of the mandible is the expanded coxa produced medially into a masticatory process. The medial portion of this process is a flat dentate plate, heavily sclerotized. The remainder of the mandible consists of a basipodite and two rami (fig. 11,*d*). The ornamentation of the basis consists of a single, slight seta inserted somewhat distal to the midpoint of the medial margin. The endopodite is placed terminally on the elongate basis and is 2-segmented. Four setae are arranged in a close-spaced row on the distolateral portion of the medial margin of the proximal segment. The somewhat larger distal segment is ornamented with seven setae. Three are widely spaced along the medial margin, the remainder are close-set along the broadly truncate terminal margin. The exopodite is inserted considerably subterminally on the basis and is extremely long and somewhat slender. The four long, slender, subequal setae are crowded into a compact row across the distal fourth of the ramus,

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with the bases so compacted as to offer the appearance of a terminal segment.

The maxillule (fig. 11,*e*) is distinctive. The basal portion is long and is expanded medially as the proximal endite. Eight masticatory setae are arranged along the medial margin of the endite. A single seta is inserted on the slight prominence representing the second endite. The epipodite is represented by a long, proximally directed seta. The basipodite is so directed that its anatomically medial setiferous margin is distal. Three long, subequal setae are inserted in an apical row. The endopodite is directed laterally and bears two widely spaced terminal setae. The exopodite bears three setae inserted along the broadly truncate distal margin.

The maxilla (fig. 11,*f*) is pentamerous, with all the segments exhibiting setiferous medial protuberances. The basal segment bears four projections upon which are inserted, respectively, three, one, two, and two setae. The second segment bears two almost equal setae. The third and fourth segments bear each a single seta. The fourth segment bears two medially inserted setae and a more reduced apical seta.

The maxilliped (fig. 11,*g*) is a flattened, subrectangular plate exhibiting marked suppression of segmentation. At the midpoint of the medial margin is borne a trio of setae inserted in a transverse row. Distally on this margin is an irregular row of five setae. Subapically on the distal lateral corner two long setae are inserted on a slight protuberance which represents the suppressed terminal segment.

Swimming legs: The first leg (fig. 11,*h*) is generalized in plan. The coxa bears a medial seta, and there is a well-developed intercoxal plate. The basipodite exhibits the characteristic oblique distal margin, the lateral edge very short. The medial margin is long, accommodating the marked distal prolongation which supports a stout, tapered, curved spine which reaches to the distal margin of the second segment of the exopodite. Each of the rami consists of three subequal segments.

The proximal segment of the exopodite bears a lateral spine and a medial seta. The second segment bears a lateral spine and a medial seta. The lateral margin of the distal segment bears three equal spines. There is a much longer apical spine, accompanied by a short, slender seta. The three medial setae are graduated in length proximally, so that the tip of the most basal one actually extends beyond that of the most distal. The spines of the two proximal segments are roughly equal in dimension with the three marginal spines of the distal segment.

The two proximal segments of the endopodite bear each a single medial seta. The six setae of the distal segment are arranged as three

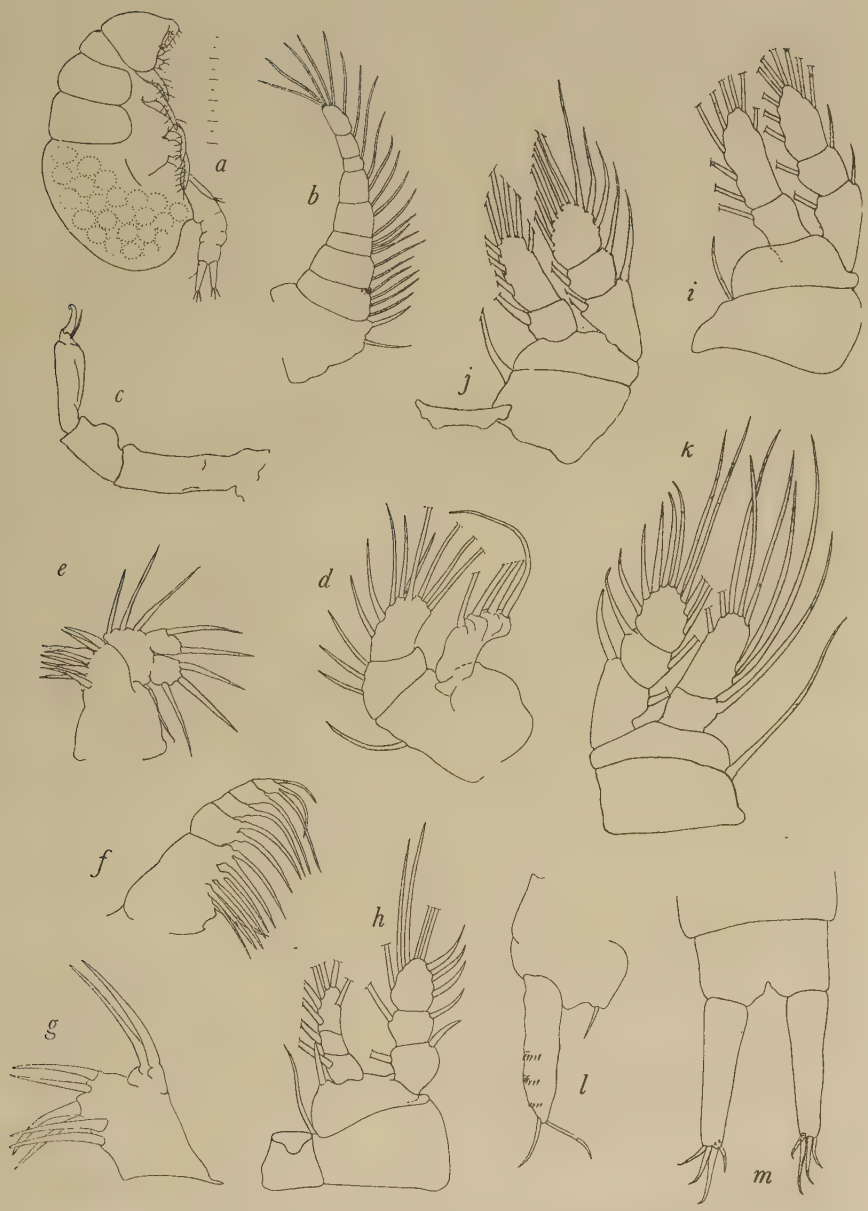


FIGURE 11.—*Doropygus schellenbergi*, new species, female: *a*, habit, lateral view; *b*, antennule; *c*, antenna; *d*, palp of mandible; *e*, maxillule; *f*, maxilla; *g*, maxilliped; *h*, first leg; *i*, second leg; *j*, third leg; *k*, fourth leg; *l*, fifth leg; *m*, caudal rami. The scale, referring to *a*, represents 0.5 mm.

along the medial margin, two apical, and one placed on an apically oriented emargination at about the midpoint of the lateral margin.

The second legs (fig. 11,*i*) consist each of a bimerous protopodite, the coxopodites yoked by a rudimentary intercoxal plate, and of a trimerous exopodite and bimerous endopodite. Each coxa bears a slender, relatively short seta at the distal medial corner. The very short lateral margin of the basis is set with a short, slender seta.

The two proximal segments of the exopodite bear each a lateral slender spine and a proximal seta. The terminal segment bears four spines and five setae, one of each apical, the remaining three spines disposed along the lateral margin, the setae medial. On each segment the portion of margin just proximal to the first spine is finely spinulose.

The basal segment of the endopodite has a single medial seta. The complement of eight setae of the terminal segment is arranged with four along the medial margin, two apical and one subterminal on the lateral edge, and one inserted at the distal fourth of the lateral margin. A pronounced constriction at the midpoint of this segment indicates its suppressed segmentation.

The third legs (fig. 11,*j*) are almost identical in proportion and ornamentation with the second legs. The formulae of spines and setae are the same in the two pairs. The spines of the exopodite are even longer and more slender and closely approach setiform dimensions.

The fourth legs (figs. 11,*k*) consist of bimerous protopodites, trimerous exopodites, and bimerous endopodites. The intercoxal plate is obsolete. Each coxa bears a slender, rather short medial seta. Each basis bears a slender lateral seta.

The two basal segments of the exopodite bear each a lateral spine and a medial seta. The terminal segment bears two lateral marginal spines, an apical spine and seta, and four medial setae. The spines are slender and markedly setiform.

The basal segment of the endopodite bears a single medial seta. The distal segment bears three setae on the medial margin, two apical setae, one subterminal laterally, and one inserted at the distal fourth of the lateral margin. The segment is constricted at the midpoint.

Vestigial legs and caudal rami: The bases of the bimerous fifth legs (fig. 11,*l*) are broad, subrectangular, and relatively massive. The length approaches the width in measure. Inserted at the lateral distal corner is a small seta. The terminal segment is articulated along the medial portion of the distal margin and its basal width is half that of this margin. The segment is slightly less than four times as long as wide. It tapers very slightly to the distal fourth, then much more markedly to the narrow apex. Two slender setae are apically inserted. Fine spinules arranged in four short rows along the medial margin furnish the remaining ornamentation.

The caudal rami (fig. 11,*m*) are notable for the rigid sclerotization of their lateral and medial margins. The lateral margin is linear, the medial so inclined as to furnish a marked taper throughout the ramus. The apical width is half the basal. The length is four times the basal width. Three graduated setae are compactly inserted across the apex. The medial of these is half again as large as that next to it and the lateral one is less than half of the size of the middle seta. The longest is over a third as long as the ramus. Inserted just proximal to the medial seta is a fourth, reduced seta. Inserted at the proximal third of the lateral margin is a small, rudimentary seta.

No male has yet been found.

### *Doropygus seclusus*, new species

FIGURE 12

TYPES: Holotypic female USNM 92806 (type locality, Washington Sound, Washington, in *Chelyosoma productum* Stimpson); allotypic male, No. 92807, and paratypes listed below.

SPECIMENS EXAMINED:

WASHINGTON

From *C. productum:*

East of Upright Channel, dredged in 25–35 fms., June 23, 1950, holotypic female, allotypic male, 29 female paratypes.

Friday Harbor, July 1928, K. L. Hobbs, 4 specimens.

Off Upright Head, Lopez Island, dredged in 15 fms., Aug. 2, 1949, 1 female.

Garrison Bay, San Juan Island, June 30, 1950, P. Knight, 4 females.

Roche Harbor, San Juan Island, growing on floats, July 6, 1950, 1 female.

Garrison Bay, San Juan Island, in lowest intertidal, July 30, 1950, 4 females.

DESCRIPTION: Female (fig. 12,*a–m*): General features: This is a large species of *Doropygus* with a markedly inflated body (fig. 12,*a*). The integument is rather heavily sclerotized so that the segments are neatly delimited. The metasome includes the head, free somites of the first, second, and third swimming legs, and the expanded incubatory segment corresponding to the fourth swimming legs. The urosome is 6-segmented. It includes two thoracic somites, of which the more anterior is that of the fifth legs. The front of the head is midventrally produced as a well-developed rostrum.

Head appendages: The antennule (fig. 12,*b*) is 9-segmented. The two basal segments are inflated. There is a considerable diminution in measurement from the second segment to the third, succeeded by a sharp taper through the third through sixth segments. The terminal three segments taper gradually. The apical segment is much longer than wide. The basal segment, measured along its greatest length, is three times as long as the apical segment. The greatest width of the basal segment is seven times that of the apical segment. The setae

are short, somewhat rudimentary, with plumose ciliation almost entirely obsolete. They are concentrated along an outer setiferous margin. The basal segment has two long stout setae at the outer distal corner, these accompanied by one or two minor setae. The second segment bears the greatest number of setae, 10 or more. Third, fourth, and fifth segments bear a small number of setae. The sixth segment is distinctive for the very long and well-developed seta inserted at the distal outer corner and bears two or more minor setae as well. The seventh and eighth segments have few setae, one or two each. The terminal segment is ornamented with six or more setae which tend in their arrangement to form an apical radiating tuft.

The antenna (fig. 12,*c*) is trimerous with the basal segment the longest. The posture of the limb is in a characteristic right-angled flexure. At the distal corner of the basal segment, internal to the flexure, are inserted two minute but distinct setules. The length of the second segment but slightly exceeds its greatest width. The segment is slightly but not markedly narrower than the first. The outer margin is longer than the medial, and the central two-thirds of the medial margin is occupied by a prominent hemispherical bulge. The terminal segment is the narrowest, about 2½ times as long as wide, and its greatest width is about two-thirds that of the second segment. Inserted on the distal end in a complicated articulation is a long, curved, stout, tapered hook. Three much-reduced setae are set on the distal end of the segment close to the articulation of the hook. Three setae form a compact cluster appressed on the surface of the segment at about its midpoint.

The mandible consists of a 2-segmented protopodite, a bimerous endopodite, and a tetramerous exopodite. The coxopodite is extended medially as the usual masticatory plate featured by a serrate inner margin. The basipodite (fig. 12,*d*) is a much-elongated segment. Near its distal medial corner is inserted a single seta. The medial portion of the terminal margin of the segment is arranged to form a wide articulation with the endopodite. The proximal segment of the endopod is a fourth again wider than the distal segment and about equal in length. Along the distal medial margin of the proximal segment is inserted a row of four setae. These are graduated markedly from a small proximal seta to an elongate distal seta. Forming a row around most of the medial margin and the whole of the truncate apical border of the terminal segment are 10 graduated setae. Seven of these form a close-spaced row. Three have their bases closely associated on a slight distolateral prominence of the segment.

The exopodite is conspicuous, long and tapered from its insertion on the basipodite to a narrow apex of about half the width of the base. The segmentation is obsolete. The four setae are arranged with three

regularly spaced along the distal half of the medial margin and one apical.

The maxillule (fig. 12,*e*) is characterized by a marked tendency to obliteration of obvious segmentation. The protopodite is obscurely 2-segmented. The basal portion supports two endites and a reduced epipodite. The proximal endite is expanded and conspicuous. Distally along its medial margin is inserted a row of nine setae, predominantly stout and sharply tapered, although two are slender. Just distal to this principal endite is a small projection terminating in a setiform elongation which is considered to represent a second endite. The epipodite is almost obsolete, represented by a long tapered seta accompanied by a minute accessory setule.

The terminal mass of the protopodite, equivalent to the basipodite, bears a distally directed row of three setae. Almost entirely laterally oriented on the apex of the protopodite are the two reduced rami, each bearing three setae. The setae of the endopodite are inserted respectively apically and upon two emarginations of the medial border. The setae of the exopodite radiate fan-wise from closely set bases along the truncate distal margin.

The maxilla (fig. 12,*f*) is pentamerous. The principal mass of the appendage consists of the basal segment which bears four setiferous prominences representing endites. The basal endite bears three setae. The second endite is represented by a single seta inserted on a very slight prominence. The third endite bears two equal setae. The fourth endite is the longest. It forms a fairly well demarcated mass bearing three members. Two of these are well developed, of about equal proportions, inserted apically. Just proximal to these is set a reduced setule.

The second segment is much wider than long. Distally this segment extends in a medial prolongation which constitutes a rather slender hook, about three-fourths as long as the principal setae of the maxilla. Inserted at the base of the hook are one well-developed long seta and an accessory reduced setule.

The two next distal segments are subequal in proportion. Inserted prominently at the distal medial corner of each of these segments is a single long seta. The reduced terminal segment bears four setae. Three of these are subequal and their bases are close-set in an apical insertion. The fourth is the smallest and is inserted on the surface of the segment toward the basal articulation. The terminal complex of three distal segments is relatively short, less than one-third again as long as the second segment.

The bimerous maxilliped (fig. 12,*g*) is relatively stocky. The medial margin bears nine setae arranged in two groups. The proximal set of setae consists of a marginal trio and a single seta displaced far

FIGURE 12.—*Doropygus seclusus*, new species. *a–m*, Female: *a*, habit, lateral view; *b*, antennule; *c*, antenna; *d*, palp of mandible; *e*, maxillule; *f*, maxilla; *g*, maxilliped; *h*, first leg; *i*, second leg; *j*, third leg; *k*, fourth leg; *l*, fifth leg; *m*, caudal ramus. *n*, Male: fourth leg. The scale, referring to *a*, represents 1.0 mm.

laterally onto the surface of the segment. The distal five setae are close-set around the curved distal medial margin. Articulated subapically and far laterally is the much-reduced distal segment. It provides insertion for two long, approximately equally developed setae. The medial margin of the terminal segment bears a row of fine, long cilia.

Swimming legs: The protopodites of the first legs (fig. 12,*h*) are conspicuously bimerous; the rami are trimerous. The coxopodites, yoked by a triangular, apically bilobed, intercoxal plate, are of rectangular outline. At the medial distal corner of each coxa is inserted a long tapering seta, the tip of which reaches just beyond the distal border of the second segment of the endopodite. The basipodite has a relatively long medial margin and a long diagonal articulation with the coxopodite. A reduced seta is inserted near the lateral margin. At the medial distal corner of the basis is articulated a well-developed tapering spine which reaches to the midpoint of the second segment of the endopodite. A curved row of spinules constitutes an ornamentation of the basis near the articulation of the endopodite. There are also a few spinules inserted near the base of the medial spine.

The segments of the exopodite are subequal. The basal is the widest, and each of the succeeding segments is diminished somewhat in width. Each of the two proximal segments bears a stout lateral spine and an elongate medial seta. Inserted on the terminal segment are three spines along the lateral margin, an apical outer spine and inner seta, and three setae along the medial border. The lateral spines are subequal in length and of about equal thickness. The apical spine is about one-fourth again longer than any of these. The proximal spine of the third segment is perhaps the shortest. All the spines have partial or extensive transparent serrated marginal flanges. The lateral margin of each segment proximal to its spine or spines is markedly spinulose, and other fine spinules form ornamentation laterally on the two proximal segments.

The two proximal segments of the endopodite bear each a medial seta. The terminal segment bears three medial marginal setae, two apical setae, and a seta inserted in an emargination at about the midpoint of the lateral margin. The medial and apical setae form a regular row and exhibit a graduated distal diminution in thickness.

The second legs (fig. 12,*i*) show the initial stages of tendencies progressively developed in the succeeding two pairs of legs. The articulation of coxopodite and basipodite is somewhat diagonal so that the lateral margin of the coxa is longer than the medial margin. There is a uniting intercoxal plate, but the distal extent of this is only short of the midpoint of the medial margin of the coxa and the plate is weakly sclerotized. There is inserted on the medial distal corner

of the coxa a well-developed seta which extends to a point at about the distal fourth of the basal segment of the endopodite.

The exopodite is trimerous. Its armature consists of the usual lateral spines and medial setae. However, the distal elements in the usual position of spines tend to setiform construction. There is a short slender lateral spine and a well-developed medial seta borne on each of the two proximal segments. On the distal segment there are three laterally inserted spines and an apical elongate spine approximating a seta in proportions. There is a medial apical seta. Inserted along the medial border are four well-developed setae. There is a fairly profuse spinose ornamentation of all the segments.

The endopodite is bimerous, with the elongate distal section preserving traces of a fundamental segmentation. The basal segment bears one medial seta. The elongate distal segment tapers only slightly apically. It bears five marginal medial setae, two apical setae, and a single seta inserted in an emargination removed proximally about a third the length of the segment from the apex. A short row of spinules curves across the face of the segment at the level of the second medial seta. There are also spinules at the bases of the lateral and apical setae and a row of spinules on the lateral distal border of the basal segment.

The line of articulation of the coxopodite and basipodite of the third legs (fig. 12,*j*) is markedly diagonal. The lateral margin of the coxa is two-thirds its width. The medial proximal corners of the coxopodites are yoked by a rudimentary intercoxal plate, the length of which approximates only one-half its width. At the distal medial corner of the coxa is borne a seta which extends to the level of the insertion of the second seta of the second segment of the endopodite.

The proximal two segments of the exopodite bear each a short slender lateral spine and a normal medial seta. The terminal segment bears three lateral spines, graduated in length, two apical setae, and four medial setae. The lateral apical seta is the shorter and is obviously somewhat spiniform.

The bimerous endopodite extends to about the midpoint of the terminal segment of the exopodite. The basal segment bears a single medial seta. The distal segment, elongate, somewhat tapered, and with vague indications of fundamental subdivision, bears five medial setae, two apical setae, and one lateral seta. Further ornamentation of the rami is provided by short rows of fine spinules.

In the protopodite of the fourth leg (fig. 12,*k*) the line of articulation of the coxopodite and basipodite is slightly diagonal so that the outer margin of the coxopodite is greater than the length of the medial margin. The coxopodites are yoked by an intercoxal plate.

This is of nearly normal proportions and the outer margins are coextensive with the medial margins of the coxa. Inserted on the distal medial corner of the coxopodite is a slender seta which extends to about the midpoint of the proximal segment of the endopodite. Near the short lateral margin of the basipodite is inserted a much-reduced setule.

The basal segment of the trimerous exopodite is elongate. It bears a short lateral spine and a very short medial seta which scarcely exceeds the spine in length. The second segment bears a lateral spine and a medial seta. The terminal segment bears three lateral spines, slightly tending toward setiform aspect, an apical spine which closely approximates setiform proportions, an apical seta, and four setae disposed along the medial border.

The endopodite is bimerous, but with the elongate second segment preserving traces of the fundamental subdivision into two podomeres. The basal segment bears a very short, reduced medial seta. The distal segment bears four setae arranged along the medial margin, two apical setae, and a lateral seta inserted in an emargination of the border of the segment opposite the insertion of the third medial seta. The lateral seta and the two more proximal setae of the distal segment are considerably reduced. A row of fine spinules ornaments the distal border of the basal segment of the endopodite and a second row curves over the surface of the distal segment at the level of the second seta. A few spinules are set at the insertions of the lateral setae of the endopodite and of the spines of the exopodite.

Vestigial legs and caudal rami: The bimerous fifth legs (fig. 12,*l*) are elongate, with expanded bases. The basal segment is over twice as wide as long and lacks ornamentation. The distal segment is five times as long as its basal width and only about a fifth of the width of the basal segment. The margins are roughly parallel, with a very slight distal taper to the somewhat narrowed apex. The armature consists of two apically inserted subequal elements, the more medial somewhat spiniform; the lateral a reduced seta. Along the medial side there are five projections interrupting the margins. These constitute elaborations of the integument related to rows of fine spinules. Each row of spinules extends a considerable distance laterally over the surface of the segment. The spinules are fine-textured, closely appressed to the segment, and not readily obvious. A sixth row is inserted at the articulation of the terminal spine.

The caudal rami (fig. 12,*m*) are relatively long, their length about four times the greatest width. The margins are nearly parallel for about half the length; distally the ramus tapers gradually and curves slightly outward, terminating in a curved apex narrowed to about one-third of the basal width. Four minute setules are inserted in a

terminal row on the apex. A setule is inserted on the lateral margin at about the proximal fourth of its length. The length of the setules is about a sixth of the apical width of the ramus.

Male (fig. 12,*n*): The sexual dimorphism in appendages of this species is expressed only in minor variations. The antennule of the male conforms very well to that in the female, except for a slight tendency to coalescence of the distal three segments, and the development of a somewhat enlarged hook-seta on the basal segment. The ornamentation of the swimming legs tends to much more spiniform aspect than in the female. In the first legs (fig. 12,*n*) the most distal setae of the endopodite are short, stiff, and sharply tapered, approaching the consistency of spines. On the posterior legs this tendency is still more marked, as was illustrated in the case of *D. mohri*. The spermatophores intrude considerably into the segment of the fifth legs. The sixth legs are bisetiferous prominences.

Remarks: The mature female of this *Doropygus* has almost always been found solitarily in the branchial cavity of the host. This species shows wide tolerance to the site of habitation of the host. Specimens have been found in ascidians collected intertidally, on floats and subtidally, by dredging.

The color of this species is striking, especially in contrast to the dull gray pallor of the host. The body varies from pink to pale orange, and the eggs are a dark red-purple.

### Species Incerta Sedis

#### *Doropygus cylindriformis* Schellenberg

*Doropygus cylindriformis* Schellenberg, 1922, pp. 240–241, figs. 21, 22 (type locality, Gulf of Suez, in *Ascidia canelata* (Sav. Ok.)).—Gurney, 1927, p. 482.—Sewell, 1949, pp. 169, 179.

Distribution: Gulf of Suez.

Host: *Ascidia canelata* (Sav. Ok.).

### Indeterminable Species

#### *Doropygus acutus* Hesse

*Doropygus acutus* Hesse, 1866, pp. 64–65 (type locality, coast of France).—Gerstaecker, 1870–1871, pp. 775, 801.

Distribution: Coast of France.

#### *Doropygus albidus* Hesse

*Doropygus albidus* Hesse, 1866, p. 61 (type locality, coast of France, in *Ascidia intestinalis*).—Gerstaecker, 1870–1871, pp. 776, 801.

Distribution: Coast of France.

Host: *Ascidia intestinalis*.

***Doropygus arcticus* Aurivillius**

*Doropygus arcticus* Aurivillius, 1885a, pp. 233-236, pl. 8, figs. 1–11 (type locality, off Pitlekaj, Siberia, from *Chelyosoma macleayanum* Sow. et Brod.); 1885b, p. 282.—Hartmeyer, 1911, p. 1734.—Wilson, 1920, p. 14.—Schellenberg, 1922, p. 240.—Lang, 1948, p. 7.

DISTRIBUTION: Arctic coast of Siberia.
HOST: *Chelyosoma macleayanum* Sow. et Brod.

***Doropygus callipygus* Hesse**

*Doropygus callipygus* Hesse, 1866, p. 58 (type locality, coast of France, in *Ascidia venosa*.—Gerstaecker, 1870–1871, pp. 776, 801.

DISTRIBUTION: Coast of France.
HOST: *Ascidia venose.*

***Doropygus coccineus* Hesse**

*Doropygus coccineus* Hesse, 1866, pp. 67–68 (type locality, coast of France).—Gerstaecker, 1870–1871, pp. 775, 801.

DISTRIBUTION: Coast of France.

***Doropygus conicus* Hesse**

*Doropygus conicus* Hesse, 1866, pp. 57–58 (type locality, coast of France, in *Cynthia microcosmus*).—Gerstaecker, 1870–1871, pp. 777, 801.

DISTRIBUTION: Coast of France.
HOST: *Cynthia microcosmus.*

***Doropygus cristatus* Hesse**

*Doropygus cristatus* Hesse, 1871, pp. 21–23, pl. 2, fig. 18 (type locality, coast of France, in *Ascidia canina*).

DISTRIBUTION: Coast of France.
HOST: *Ascidia canina.*

***Doropygus curculio* Hesse**

*Doropygus curculio* Hesse, 1866, pp. 54–55 (type locality, coast of France).—Gerstaecker, 1870–8171, pp. 775, 801.

DISTRIBUTION: Coast of France.

***Doropygus deflexus* Hesse**

*Doropygus deflexus* Hesse, 1866, pp. 58–59 (type locality, coast of France).—Gerstaecker, 1870–1871, pp. 778, 801.

DISTRIBUTION: Coast of France.

***Doropygus gibbosus* Hesse**

*Doropygus gibbosus* Hesse, 1866, pp. 62–63 (type locality, coast of France, in *Ascidia intestinalis*).—Gerstaecker, 1870–1871, pp. 776, 801.

DISTRIBUTION: Coast of France.
HOST: *Ascidia intestinalis.*

### *Doropygus globosipherus* Hesse

*Doropygus globosipherus* Hesse, 1869, pp. 307–308 (type locality, coast of France).—Gerstaecker, 1870–1871, pp. 775, 801.—Della Valle, 1883, p. 245.

DISTRIBUTION: Coast of France.

### *Doropygus macroon* Hesse

*Doropygus macroon* Hesse, 1866, pp. 66–67 (type locality, coast of France).—Gerstaecker, 1870–1871, pp. 775, 801.

DISTRIBUTION: Coast of France.

### *Doropygus molgulensis* Pearse

*Doropygus molgulensis* Pearse, 1952, pp. 188–189, fig. 1 (type locality, Alligator Harbor, Fla., in *Molgula occidentalis* Traustedt).

DISTRIBUTION: Florida.
HOST: *Molgula occidentalis* Traustedt.

### *Doropygus oblongus* Hesse

*Doropygus oblongus* Hesse, 1866, p. 59 (type locality, coast of France, in *Polyclinum stellatum*).—Gerstaecker, 1870–1871, pp. 774, 801.—Della Valle, 1883, p. 245.

DISTRIBUTION: Coast of France.
HOST: *Polyclinum stellatum.*

### *Doropygus ponticus* Grebnitskiĭ

*Doropygus ponticus* Grebnitskiĭ, 1873–1874, pp. 218, 246 (type locality, Black Sea).

DISTRIBUTION: Black Sea.

### *Doropygus postremoglobosus* Hesse

*Doropygus postremoglobosus* Hesse, 1871, pp. 23–24 (type locality, coast of France, in *Ascidia canina*).

DISTRIBUTION: Coast of France.
HOST: *Ascidia canina.*

### *Doropygus propinquus* Hesse

*Doropygus propinquus* Hesse, 1866, pp. 56–57 (type locality, coast of France).—Gerstaecker, 1870–1871, pp. 775, 801.

DISTRIBUTION: Coast of France.

### *Doropygus reflexus* Hesse

*Doropygus reflexus* Hesse, 1866, pp. 65–66 (type locality, coast of France, in *Ascidia venosa*).—Gerstaecker, 1870–1871, pp. 776, 801.

DISTRIBUTION: Coast of France.
HOST: *Ascidia venosa.*

### *Doropygus rotundus* Hesse

*Doropygus rotundus* Hesse, 1866, p. 60 (type locality, coast of France, in *Ascidia aspesa* [sic]).—Gerstaecker, 1870–1871, pp. 775, 801.

DISTRIBUTION: Coast of France.
HOST: *Ascidia aspesa* [sic].

### *Doropygus rufescens* Hesse

*Doropygus refescens* Hesse, 1866, p. 67 (type locality, coast of France).—Gerstaecker, 1870–1871, pp. 774, 801.—Della Valle, 1883, p. 245.

DISTRIBUTION: Coast of France.

### *Doropygus sphaerasipherus* Hesse

*Doropygus sphaerasipherus* Hesse, 1869, pp. 305–307 (type locality, coast of France).—Gerstaecker, 1870–1871, pp. 775, 801.—Della Valle, 1883, p. 245.

DISTRIBUTION: Coast of France.

### *Doropygus tumefactus* Hesse

*Doropygus tumefactus* Hesse, 1866, p. 63 (type locality, coast of France).—Gerstaecker, 1870–1871, pp. 775, 801.

DISTRIBUTION: Coast of France.

### *Doropygus verrucosus* Hesse

*Doropygus verrucosus* Hesse, 1866, pp. 60–61 (type locality, coast of France, in *Ascidia venosa*).—Gerstaecker, 1870–1871, pp. 776, 801.

DISTRIBUTION: Coast of France.
HOST: *Ascidia venosa.*

### *Doropygus viridis* Hesse

*Doropygus viridis* Hesse, 1866, p. 61 (type locality, coast of France, in *Cynthia microcosmus*).—Gerstaecker, 1870–1871, pp. 777, 801.

DISTRIBUTION: Coast of France.
HOST: *Cynthia microcosmus.*

### *Doropygus* sp. Herdman

*Doropygus* n. sp. Herdman, 1889, p. 254.

DISTRIBUTION: Off Liverpool; Loch Fyne.
HOSTS: *Polycarpa pomaria* Savigny, *Styela rustica.*

## NOMINA NUDA

### *Doropygus coeruleus* Sewell

*Doropygus coeruleus* Sewell, 1949, p. 157.

### *Doropygus gibbosa* T. Scott

*Doropygus gibbosa* T. Scott, 1901, p. 351.—Sewell, 1949, p. 188

## Genus *Doropygella* G. Sars, emended

*Doropygus* Thorell, 1859a, pp. 43–46 (part).—Aurivillius, 1882b, p. 49.—Giesbrecht, 1882a, pp. 324–326 (part).—Canu, 1892, pp. 193–194 (part).—Schellenberg, 1922, pp. 238–241 (part).

*Doropygella* G. Sars, 1921, p. 49 (type species, by monotypy, *Doropygus thorelli* Aurivillius, 1882b).—Wilson, 1932, p. 599.

*Doropygelia* Wilson, 1936, p. 376.

The differentiation of this genus from *Doropygus* has already been discussed under the latter. The outstanding features of the generic diagnosis of *Doropygella* are as follows. The urosome, including segment of fifth legs, is 5-segmented. The exopodite of the maxillule bears four setae; the endopodite bears six or more, and may preserve indications of a bimerous condition. The maxilliped, basically trimerous with unornamented second segment, may be reduced to bimerous with terminal segment bearing three setae or the segmentation may be obsolete with two terminal setae present. The remaining appendages are specifically variable.

### Key to the species of *Doropygella*, based upon females

1*a*. Caudal rami very long, coiled at the tip . . . . . **porcicauda** (p. 590)
1*b*. Caudal rami not terminally coiled . . . . . 2
2*a*. Armature of lateral margins of third and fourth exopodites long setae **normani** (p. 590)
2*b*. Armature of lateral margins of third and fourth exopodites spines . . . . 3
3*a*. Caudal rami no more than 2 or 3 times as long as wide . . **thorelli** (p. 591)
3*b*. Caudal rami 5 or more times longer than wide . . . . . **psyllus** (p. 591)

#### Species not known from North America

#### *Doropygella normani* (Brady), new combination

*Doropygus normani* Brady, 1878, pp. 136–138, pl. 32, figs. 1–14 (type locality, Ireland).—Richiardi, 1880, p. 147.—Giesbrecht, 1882a, p. 324.—Carus, 1885, p. 342.—Gourret, 1888, p. 1.—Herdman, 1889, p. 254.—T. Scott, 1891, p. 301; 1902, p. 455; 1906, p. 363; 1907, p. 364.—Thompson and Scott, 1903, p. 255.—Norman, 1905, p. 36.—Pesta, 1909, p. 259.—Schellenberg, 1922, p. 241.—Sewell, 1949, pp. 169, 176, 177, 182.

Distribution: Mediterranean and British Isles; Ceylon.

Hosts: ? *Ascidia virginea*, *Cynthia papillosa* L., *Cynthia* sp., *Styela rustica*.

#### *Doropygella porcicauda* (Brady), new combination

*Doropygus porcicauda*, Brady, 1878, pp. 138–140, pl. 27, figs. 1–9, pl. 33, figs. 14–16 (type locality, British Isles, in *Ascidia parallelogramma*).—Giesbrecht, 1882a, p. 324.—Herdman, 1889, p. 249.—Thompson, 1889, pp. 185–186; 1893, p. 190, pl. 18, fig. 1.—T. Scott, 1888, p. 239; 1897, p. 148; 1900, p. 386; 1901, p. 351; 1906, p. 363; 1907, p. 364.—Norman and Brady, 1909, p. 401.—Pesta, 1909, p. 259.—G. Sars, 1921, pp. 45–46, pl. 22.—Schellenberg, 1922, pp. 241, 264.—Gray, 1933, pp. 520–521.—Gurney, 1933, p. 304.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 119.—Sewell, 1949, p. 188.

DISTRIBUTION: British Isles, Norway.

HOSTS: *Ascidia parallelogramma*, A. *plebeia* Alder.

***Doropygella psyllus* (Thorell), new combination**

*Doropygus psyllus* Thorell, 1859a, pp. 49–50, pl. 7, fig. 9 (type locality, coast of Sweden, in *Ascidia aspersa* Müller); 1859b, pp. 339, 343; 1860, pp. 118, 123.—Hesse, 1866, pp. 54, 64.—Gerstaecker, 1870–1871, pp. 775, 801.—Kerschner, 1879, pp. 185–186.—Aurivillius, 1882a, pp. 54–55; 1882b, p. 112; 1883, pp. 24–25, 108.—Giesbrecht, 1882a, p. 324.—Carus, 1885, p. 342.—Gourret, 1888, p. 1.—Canu, 1891, p. 472; 1892, pp. 194–195, pl. 8, figs. 1–11.—Graeffe, 1902, p. 39.—T. Scott, 1907, pp. 364–365.—Pesta, 1909, p. 259.—Hartmeyer, 1911, p. 1735.—G. Sars, 1921, pp. 44–45, pl. 21.—Schellenberg, 1922, pp. 241, 265.—Brian, 1924, p. 7.—Harant, 1931, p. 370.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 119.—Lang, 1948, p. 2—Sewell, 1949, pp. 182, 188, 191.

DISTRIBUTION: Mediterranean to Sweden and Norway.

HOSTS: *Ascidia aspersa* Müeller, *A. fumigata*, *Phallusia patula*, *P. virginea*.

NORTH AMERICAN SPECIES

***Doropygella thorelli* (Aurivillius)**

*Doropygus thorelli* Aurivillius, 1882b, pp. 49–60, 112, pl. 13, fig. 10, pl. 14, figs. 1–14 (type locality, Sweden, in *Phallusia mentula*); 1883, pp. 45–56, 108, pl. 4, fig. 10, pl. 5, figs. 1–14.—Schellenberg, 1922, pp. 240, 265.

*Doropygella thorelli* G. Sars, 1921, pp. 49–50, pl. 24.—Hansen, 1923, p. 23.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 120, fig. 70.—Stephensen, 1929, p. 7; 1940, pp. 2–3, 18, 20.—Sewell, 1949, p. 191.

*Doropygella thorellii* Wilson, 1936, p. 368.

*Doropygelia thorellii* Wilson, 1936, p. 376.

DISTRIBUTION: Norway and Sweden, Faröes, Iceland, Greenland, Davis Strait, Foxe Channel.

HOSTS: *Ascidia obliqua*, *Phallusia mentula*.

REMARKS: No specimens were available for the present study. The species has been thoroughly illustrated by G. Sars (1921, pl. 24).

## Genus *Doropygopsis* G. Sars

*Doropygus* Aurivillius, 1882a, pp. 48–54 (part).—Schellenberg, 1922, pp. 238–241 (part).

*Doropygopsis* G. Sars, 1921, pp. 46–47 (type species, by monotypy, *Doropygus longicauda* Aurivillius, 1882).—Wilson, 1932, p. 598.

The basis of subdivision of this genus from the original concept of *Doropygus* is discussed under the latter. The principal features involved in the characterization of *Doropygopsis* are as follows.

The urosome is pentamerous, including the thoracic segment of the fifth legs and also a second, genital somite composed of both thoracic

and abdominal elements. The ornamentation of the caudal rami is fairly well developed, consisting of relatively normal short setae.

The antennule is 9-segmented. The antenna is trimerous with setation relatively unreduced. The maxillule presents the distinctive feature in the endopodite of presence of seven to nine setae. The exopodite bears the usual four setae. The maxilliped is trimerous with all segments setiferous.

The remaining appendages are more or less generalized in structure, conforming to the least specialized condition found in either *Notodelphys* or *Doropygus*.

### Key to the species of *Doropygopsis*, based upon females

1*a*. Endopodite of maxillule with 7 setae . . . . . **longicauda** (p. 592)
1*b*. Endopodite of maxillule with 9 setae . . . . . **novemsetiferus** (p. 592)

#### Species not known from North America

#### *Doropygopsis novemsetiferus* (Schellenberg), new combination

*Doropygus novemsetiferus* Schellenberg 1922, p. 244 (type locality, Gulf of Suez, in *Styela canopus* Sav. and *Pyura gangelion* (Sav.).—Gurney, 1927, p. 480.—Sewell, 1949, pp. 169, 179.

Distribution: Gulf of Suez.

Hosts: *Styela canopus* Sav., *Pyura gangelion* (Sav.).

#### North American Species

#### *Doropygopsis longicauda* (Aurivillius)

*Doropygus longicauda* Aurivillius, 1882a, pp. 48–54, pl. 7, figs. 1–12 (type locality, Bohuslan, Sweden, in *Phallusia obliqua*); 1882b, pp. 60–61, pl. 13, fig. 11; 1883, pp. 18–24, 56–57, 108, pl. 3, figs. 1–12, pl. 4, fig. 11; 1886, pp. 43–44, pl. 1, figs. 1–6.—Schellenberg, 1922, pp. 240, 264.

*Doropygopsis longicauda* G. Sars, 1921, pp. 47–49, pl. 23.—Hansen, 1923, pp. 22–23.—Stephensen, 1932, p. 3; 1940, pp. 2, 18, 20.—Blake, 1933, p. 226.—Pesta, 1934, p. 8.—? Wilson, 1935a, p. 779.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 119, fig. 69.—Lang, 1948, p. 2.—Sewell, 1949, pp. 161, 191–194.

Distribution: Sweden and Norway, Spitzbergen, Kara Sea, Faröes, Iceland, Greenland, Davis Strait, Maine, ? California.

Hosts: *Phallusia obliqua*, *P. mentula*, *Ascidia callosa*, *A. prunum*, *Boltenia echinata*, ?*Eugyra* sp.

Specimens examined:

Canada

From *Ascidia* sp.:

Off Grand Manan Island, New Brunswick, dredged in 97–110 fms., 1872, U. S. Fish Comm. Station 5028, 1 female.

Near entrance to Goose Bay, Lake Melville, Labrador, dredged 17–19 fms., Aug. 26, 1951, D. C. Nutt, 3 females.

From *Ascidia prunum* Müller:

Lake Melville, Labrador, dredged, July–August 1950, D. C. Nutt, 1 female.

From unidentified ascidians:

Off Labrador, lat. 53°22.3′ N., long. 55°56.7′ W., dredged in 35 fms., July 12, 1949, D. C. Nutt, 3 females.

Soak Point, Hebron Fjord, Labrador, dredged in 13 fms., Aug. 31, 1949, D. C. Nutt, 3 females, 4 males.

Off Labrador, 53°52′ N., long. 59°19′ W., dredged in 30–35 fms., July 11, 1950, D. C. Nutt, 5 specimens.

WASHINGTON

From *Ascidia callosa* Stimpson:

Off Dinner Island, San Juan Island, dredged in 30 fms., Aug. 10, 1949, R. L. Fernald, 3 females, 1 male.

East of Upright Channel, dredged, June 23, 1950, 3 females.

From *Ascidia paratropa* (Huntsman):

Off Upright Head, Lopez Island, dredged in 15 fms., July 27, 1949, R. L. Fernald, 1 female.

Upright Channel, dredged, July 19, 1950, 2 females.

From *Halocynthia igaboja* (Oka):

Off Upright Head, Lopez Island, dredged, June 23, 1950, 1 female.

DESCRIPTION: Female: General features: Thorough illustration of this species has been provided by G. Sars (1921, pl. 23). The body is compressed, the metasome modified by the greatly expanded incubatorium. The head includes the segment of the maxillipeds and is characterized by wide-flaring lateral epimeral expansion. The segment of the first swimming legs is free, but seemingly lacks epimera. The segments of the second and third legs are much larger in size than the first segment and present well-developed, closely appressed epimeral plates. The fourth segment is the much-inflated brood sack. The major body articulation is between the segments of the fourth and fifth legs, since the latter segment does not conspicuously participate in the structure of the brood sack. The urosome is 5-segmented. The second segment is apparently a "genital somite" formed by coalescence of the last thoracic segment and first abdominal somite. There are three free abdominal segments, the last supporting the well-developed caudal rami.

A conspicuous rostrum is produced ventrally from the anterior tip of the head. It is bluntly pointed and relatively flattened.

Head appendages: The antennule is 9-segmented. The two basal segments are much expanded and so articulated on the head and with each other as to provide a nearly right-angled flexure. The third segment is much narrower than the second. The terminal six segments are graduated in a fairly regular, slight taper. The terminal segment is about an eighth as thick as the first segment and two-thirds as thick as the third segment. Most of the distal segments are slightly longer than wide. The sixth segment is twice as long as wide.

The seventh segment is roughly subquadrate. The terminal segment is twice as long as wide. Several segments are distinctive for the possession of one or more very long, basally stout setae. Two of these are inserted on each of the first two segments. Segments five and six bear one each. In addition, each segment bears a number of shorter, slender setae. The approximate count of setae by segments is: 1–3; 2–10 plus; 3–3; 4–3; 5–4; 6–3; 7–1; 8–2; 9–6. The larger setae are plumose and of fairly stiff consistency.

The trimerous antenna presents no indication of the fusion of the two more proximal segments of the antenna of the type found in *Notodelphys*. A long plumose seta is inserted terminally on the basal segment. The basal segment is twice as long as its greatest width. The second segment is 1½ times as long as wide, and two-thirds the length of the basal segment. The distal segment is slightly constricted basally and is the longest segment of the appendage. Its length is nearly four times its greatest width. Terminally there is articulated a stout, tapered, curved claw. Several setae, of varying lengths, are inserted apically, close to the base of the claw. At about the distal fourth of the segment there is inserted a compact row of three graduated setae which lie closely appressed to the surface of the segment. Just proximal to these is set a short marginal seta.

The mandible differs from that of *Notodelphys*. The masticatory plate of the coxa is ornamented along the medial edge by four principal tooth-like projections, a saw-edge of fine, close-spaced denticles, and two fine, setalike members. The basipodite is widely expanded. At the distal fourth of the medial margin is inserted one well-developed seta. The endopodite is bimerous. The subquadrate basal segment bears four setae, arranged as a row around the distal medial corner. The margins of the terminal segment are parallel, the length is about 1½ times the width, and the segment is about three-fourths the greatest width of the basal segment. Nine setae form a close-set row along the distal three-fourths of the medial margin and across the terminal border. The exopodite is a broad, flat plate with the segmentation obsolete. Five very long subequal setae are disposed along the distal expanse of the ramus.

The protopodite of the maxillule is elongate and rather narrow. The segmentation is strongly indicated. A small lateral protuberance, doubtless representing the epipodite, furnishes insertion for a long, stout, proximally directed seta and a short accessory setule. Medially there are two projections, probably representing endites. The proximal endite is a greatly developed, flaring prominence bearing a row of nine masticatory setae close-set along the medial margin. Just distal to this endite is the slight prominence of the second, produced distally as an elongate, tapering, setiform structure. The distal portion of the

protopodite is produced apically, directing the rami laterally. A trio of basipodal setae ornament the distal medial margin of the second segment of the protopodite. The endopodite is bimerous. The first segment bears three setae on the medial margin. The minute distal segment bears four setae disposed along the apical margin. Four long, stout, almost equal setae are arranged fan-wise across the outer margin of the exopodite.

The pentamerous maxilla preserves indications of further division of the basal segment. This proximal segment is complicated medially by the production of the margin as four setiferous lobes, presumably the counterparts of endites. The basal prominence bears three setae. The second prominence bears a single straight seta. The third endite bears two equal setae. The fourth endite is fairly well developed and bears two equal setae and an accessory setule. The second segment is produced medially as a heavy, tapered, curved, stout hook, bearing denticulations along the proximal edge. One seta is inserted basally on the hook-process accompanied by a minute setule. The succeeding two segments are very slender. On the distal medial corner of each is inserted a well-developed seta. The apical segment is much reduced. Its ornamentation consists of an apical trio of subequal setae.

The trimerous maxilliped is markedly slender and elongate. The basal segment bears eight setae arranged in two groups. Proximally, three setae are set close together along the margin. A quartet of setae is disposed around the distal medial corner and a large superficial seta is inserted near their bases. The second segment is rectangular, about a fourth again as long as wide. A single large seta is inserted at the distal medial corner. The distal segment is a truncated cone, its length 1½ times its greatest width. There are two setae inserted along the medial margin, and at the apex are inserted two long, subequal, plumose setae.

Swimming legs: The protopodite segments of the first legs are somewhat elongated. The intercoxal plate is slightly reduced. Inserted on the medial distal corner of the coxa is a slender seta which extends to the midpoint of the first segment of the endopodite. The basipodite is characterized by a very short lateral margin, near which is set a moderate-sized seta, and a much longer medial margin. At the distal medial corner of the basis is articulated a slender tapering spine which reaches to the distal margin of the first segment of the endopodite.

The rami are trimerous. The large basal segment of the exopodite bears a lateral spine and a well-developed medial seta. The second segment bears one much shorter, slighter lateral spine and a medial seta. The distal segment bears three lateral spines, an apical spine and seta, and three medial setae. The dimensions of the spines of the distal segment are varied. The proximal spine is very short. The

two next distal spines are slender but more elongate. The apical spine is slender and half again as long as the next longest spine.

The endopodite tapers somewhat from a distinctly thickened basal segment. The first two segments each bear a single medial seta. The terminal segment bears three medial setae, two apical setae, and a single seta inserted about midway on the lateral margin. Fine spinules form short rows ornamenting each of the segments of the endopodite and the basipodite near its medial spine, and produce a fine serration along the lateral margins of the segments of the exopodite.

The protopodites of the second legs are very long in proportion to width. The coxopodites are linked by a somewhat reduced intercoxal plate. At the distal medial corner of each coxa is inserted a slender seta. The only ornamentation of the basipodite is a reduced seta inserted near the short lateral margin.

The trimerous exopodite is slender and elongate. All the spinous elements of the armature are considerably setiform. Each of the two basal segments bears a lateral setiform spine and a medial seta. The distal segment bears three lateral setiform spines, graduated somewhat in length, two apical setae (the lateral one representing a spine), and four medial setae.

The endopodite is trimerous. The elongate third segment exhibits a most distinctive outline produced by strong medial emarginations into which the setae are inserted. The basal segment bears a single medial seta. The second segment bears two medial setae. The distal segment bears three medial setae, two apical setae, and a lateral seta inserted at the distal third.

The third legs are somewhat elongate and narrowed. The coxopodites are more or less rectangular and they are united by a reduced intercoxal plate. At the distal medial corner of the coxa is inserted a slender seta which does not quite reach the distal margin of the first segment of the endopodite. The armature of the basipodite consists of a single reduced seta inserted near the short lateral margin.

The basal segment of the trimerous exopodite is elongated. The second segment is slightly prolonged, subquadrate. The distal segment is elongate and tapered. All the elements of the armature are more or less setiform.

The basal segment bears a short, rigid, lateral, setiform spine and a medial seta. The second segment bears a lateral, elongate, setiform spine and a medial seta. The terminal segment bears three lateral setiform spines, two apical setae, and four medial setae.

The trimerous endopodite is elongate, mainly due to the pronounced extension of the distal segment, which is twice as long as the basal segment. All segments are relatively slender, the basal segment being a little longer than wide. The first segment bears a single medial seta.

The second segment bears two medial setae. The terminal segment bears three medial setae, two apical setae, and a lateral seta inserted at about the midpoint of the segment.

The protopodites of the fourth legs are elongate and slightly tapered to a somewhat conical aspect. The coxopodites are united by an intercoxal plate. At the distal medial corner of the coxa is inserted a small seta which extends just beyond the midpoint of the basal segment of the endopodite. Inserted near the very short lateral margin of the basipodite is a short, much-reduced seta.

All elements of the armature of the exopodite are setiform. The basal segment bears a short, lateral setiform spine and a medial seta. The second segment bears a lateral setiform spine and a medial seta. The terminal segment bears two lateral setiform spines, two apical setae, and four medial setae.

The trimerous endopodite is elongate. The basal segment is about as long as its greatest width and it bears a medial seta. The second segment bears two medial setae. The outline of the somewhat tapered third segment is characterized by emarginations accommodating the insertions of lateral and medial marginal setae. There are two medial setae, two apical setae, and one lateral seta.

Vestigial legs and caudal rami: The bimerous fifth legs are markedly elongate. The basal segment articulates along a diagonal line with the main mass of the body. There is a laterally inserted seta. The distal segment is half as wide as the basal segment, about 4½ times as long as wide, and exhibits a gradual distal taper. Inserted terminally on the distal segment are two unequal setae, one being half the length of the other. Along the distal half of the medial margin are set five or more curving rows of fine spinules, each row accommodated by a slight emargination of the integument.

The caudal rami are slightly over six times as long as their greatest width. They taper markedly but uniformly to the apex, which is half as wide as the base. Inserted on the apex are two long central setae, accompanied by one short lateral seta and a short medial seta. The longest seta is about two-thirds as long as the ramus. The short setae are between a third and a half of this length. Inserted on the lateral margin in a slight emargination at the proximal fourth is a short, slight seta. Another is set on the medial margin at its distal fourth. Ciliation of the setae of the ramus is reduced or obsolete.

Sars has provided an illustration of the male of this species. The outstanding feature of the sexual dimorphism is the possession of paired geniculate antennules. These are 10-segmented, with the articulation falling between the two terminal, much-elongate segments. The urosome of the male, including the somite of the fifth legs, is 6-segmented.

REMARKS: Sars described the color of females of this species as uniform light reddish, with the eggs somewhat darker. Specimens from *Ascidia callosa* in Washington Sound were recorded as reddish orange.

The southernmost occurrence of this species in North America is not quite clearly established. Wilson (1935a) published a report of finding it in ascidians from California. Examination of specimens in the collections of the U. S. National Museum labeled to correspond with this record has not substantiated the identification. All the specimens so far found are other species of notodelphyids. Most specimens are assignable to the new genus *Pygodelphys*. It is possible, however, that the whole of the material examined by Wilson is not in the Museum collections.

### *Pygodelphys*, new genus

*Doropygus* Schellenberg, 1922, pp. 238–241 (part).

TYPE SPECIES: *Pygodelphys aquilonaris*, new species.

DESCRIPTION AND DISCUSSION OF TAXONOMIC CHARACTERS: The differentiation of this genus from *Doropygus* was discussed under the latter. Four North American and Antarctic-Sub-Antarctic species form a coherent group which can best be treated by recognition of generic status. In many features *Pygodelphys* exhibits a transitional grade of structure between *Notodelphys* and *Doropygus*.

The body is compressed, with 5-segmented metasome and 5-segmented urosome. The fifth legs are borne on the metasome and the first urosomal segment is the genital somite. The caudal rami are of moderate size, well sclerotized, and bear relatively well-developed setae.

The antennule is intermediate between those of *Notodelphys* and *Doropygus*. Composed of nine or ten segments, it is long and the setation is profuse.

The antenna, mandible, maxillule, and maxilla much resemble those of *Notodelphys*, with close conformity of segmentation and ornamentation.

The maxilliped is much like that of *Doropygus*, distinctive in proportion, perhaps, but similar in basic structure. It is bimerous; the armature of the terminal segment is two robust plumose setae.

The swimming legs are highly characteristic. The first legs are most nearly generalized, with a well differentiated pattern of arrangement of spines. The posterior legs are elongate, with much modification of the armature, which is predominantly setiform. The endo-

podites tend toward coalescence of segments, accompanied by great prolongation. In most species the endopodites are flat lamellae.

The fifth legs are distinctive. They seem best derivable from the structure found in *Notodelphys*, but they are much reduced, consisting of two roughly equivalent setiferous lobes.

Sexual dimorphism of the appendages is less highly developed than in *Notodelphys*. It is comparable to the degree found in species of *Doropygus* having the most extreme differentiation.

### Key to the species of *Pygodelphys*, based upon females

1*a*. Antennules with 9 segments. . . . . **novaeseelandiae** (p. 599)
1*b*. Antennules with 10 segments. . . . . 2
2*a*. Furca pointed apically, with stiff, saber-shaped terminal setae. **antarctica** (p. 599)
2*b*. Furca blunt apically, with spirally curled terminal setae. . . . . 3
3*a*. Terminal 4 segments of antennule much elongate . . . **lamellipes** (p. 599)
3*b*. Seventh segment of antennule much elongate, 3 terminal segments subquadrate. . . . . **aquilonaris** (p. 600)

#### Species not known from North America

***Pygodelphys antarctica* (Schellenberg), new combination**

*Doropygus antarcticus* Schellenberg, 1922, pp. 243, 264 (type localities: Falkland Islands; Tierra del Fuego, in *Paramolgula gigantea* (Cun.)).—Sewell, 1949, p. 174.

Distribution: Falkland Islands and Tierra del Fuego.
Host: *Paramolgula gigantea* (Cun.)

***Pygodelphys lamellipes* (Schellenberg), new combination**

*Doropygus lamellipes* Schellenberg, 1922, pp. 242–243, 264, fig. 23 (type localities: Falkland Islands and Tierra del Fuego, in *Styela paessleri* Mchlsn.).—Sewell, 1949, p. 174.

Distribution: Falkland Islands and Tierra del Fuego.
Host: *Styela paessleri* Mchlsn.

***Pygodelphys novaeseelandiae* (Schellenberg), new combination**

*Doropygus novae seelandius* Schellenberg, 1922, pp. 244–245, 264 (type locality, New Zealand, in *Pyura pulla* Sluit., *Paramolgula filholi* (Piz.), *Cnemidocarpa novae-seelandiae* Mchlsn.).
*Doropygus novaesealandicus* Sewell, 1949, p. 163.

Distribution: New Zealand.
Hosts: *Pyura pulla* Sluit., *Paramolgula filholi* (Piz.), *Cnemidocarpa novae-seelandiae* Mchlsn.

NORTH AMERICAN SPECIES

***Pygodelphys aquilonaris*, new species**

FIGURES 13, 14

TYPES: Holotypic female, USNM 92812 (type locality, Washington Sound, Wash., in *Pyura haustor* (Stimpson)); allotypic male, USNM 92813; paratypes, all specimens listed below.

SPECIMENS EXAMINED:

ALASKA

From *Halocynthia aurantium*, (Pallas):

Unalaska Island, October 1878, L. M. Turner, 1 female, 1 male.

BRITISH COLUMBIA

From *Ascidia paratropa* (Huntsman):

Departure Bay, Jan. 20, 1931, G. H. Wailes, 1 female.

WASHINGTON

From *Pyura haustor:*

Off Johns Island, July 5, 1939, dredged, types above.

Mitchell Bay, on floats, July 13, 1950, 1 female.

Indian Cove, Shaw Island, Aug. 18, 1948, dredged, 6 fms., R. L. Fernald, 6 specimens.

East of Upright Head, Lopez Island, June 23, 1950, dredged in 25–35 fms., 15 females.

Near Canoe Island, Off Shaw Island, July 1, 1950, dredged, 2 females.

Just north of east end of Lopez Pass, July 15, 1950, dredged, 3 females.

From *Halocynthia aurantium:*

Near Friday Harbor, July 1950, from polyp of *Endocrypta huntsmani* (Fraser) in branchial cavity, 1 female.

From *Styela gibbsii* (Stimpson):

Off Upright Head, Lopez Island, Aug. 2, 1949, R. L. Fernald, 4 females.

East of Upright Channel, June 23, 1950, dredged in 25–35 fms., 45 females.

Just north of outer end of Lopez Pass, July 15, 1950, dredged, 2 females.

From *Cnemidocarpa finmarkiensis* (Kiaer):

Brown's Island, Friday Harbor, July 1, 1950, intertidal, R. L. Fernald, 10 plus specimens.

Outer end of Lopez Pass, July 15, 1950, dredged, 6 specimens.

Minnesota Reef, Turn Point, San Juan Island, July 16, 1950, intertidal, 1 female.

From *Boltenia villosa* (Stimpson):

Obstruction Pass, Orcas Island, Aug. 18, 1948, dredged in 16 fms., R. L. Fernald, 11 specimens.

Upright Channel, San Juan Island, June 23, 1950, 10 females.

Just north of outer end of Lopez Pass, July 15, 1950, dredged, 5 females.

Upright Channel, July 19, 1950, dredged, 20 specimens.

From *Chelyosoma productum* Stimpson:

East of Upright Channel, June 23, 1950, dredged in 25–35 fathoms, 3 females, 1 male.

OREGON

From *S. gibbsii:*

Off Alseya River, Sept. 3, 1889, 116 fms., U. S. Fish Comm. Steamer *Albatross*, 3 females.

California

From *Eugyra* sp.:

Corona del Mar, 1934, G. E. MacGinitie, 1 female.

In ascidian:

Corona del Mar, Aug. 1, 1933, 17 fms., G. E. MacGinitie, 2 females.

From *Molgula regularis* Ritter:

Scorpion Harbor, Santa Cruz Island, July 26, 1939, in 20 fms., W. G. Hewatt, 5 females.

Description: Female (figs. 13,*a–l*, 14,*m–s*): General features: The body (fig. 13,*a*) is compressed, with 5-segmented metasome and well-developed 5-segmented urosome. The metasomal components are the head, well-developed free thoracic somites of the first to third legs, and the large incubatory segment bearing the fourth and fifth legs. The first urosomal segment (fig. 13,*b*) is the thoracic genital somite. The remaining segments are abdominal. The head is produced ventrally at the apex into a stout rostrum.

Head appendages: The antennule (fig. 13,*c*) is 10-segmented. The two basal segments are much expanded and so articulated on the head and with each other as to provide a right-angled flexure. The third segment is much narrower than the second. The terminal seven segments are graduated in a fairly regular, slight taper. The terminal three segments are subquadrate in outline and the proximal two of these bear a distinctive ornamentation of fine spinules. Most of the remaining segments are slightly wider than long. Several segments are distinctive for the possession of one or more very long, basally stout setae. Two of these are inserted on each of the first two segments. Segments seven and ten bear one each. In addition, each segment bears a number of shorter, slender setae. The count of setae by segments is: 1–3; 2–10; 3–2; 4–3; 5–1; 6–2; 7–2; 8–2; 9–2; 10–7. The setae are plumose and of fairly stiff consistency.

The bimerous antenna (fig. 13,*d*) preserves only traces of the probable derivation by fusion of the two more proximal segments of the antenna of the type found in *Notodelphys*. Diagonal sulci in the integument at the distal sixth of the basal segment are related to the close-set insertions of two long, plumose, subequal setae. A short, reduced seta is inserted on the margin opposite to that bearing the two setae. The basal segment is five times as long as its greatest width. The second segment is nearly four times as long as wide and approximately three-fifths of the length of the basal segment. Terminally there is articulated a stout, tapered, curved claw. Six setae, of varying lengths, are inserted apically, close to the base of the claw. At about the distal fourth of the segment there is inserted a compact row of three graduated setae which lie closely appressed to the surface of the segment. Just proximal to these is set a short marginal seta.

FIGURE 13.—*Pygodelphys aquilonaris*, new species, female: *a*, habit, lateral view; *b*, urosome; *c*, antennule; *d*, antenna; *e*, masticatory lamella of mandible; *f*, palp of mandible; *g*, maxillule; *h*, maxilla; *i*, maxilliped; *j*, first leg; *k*, spine from segment 2 of first exopodite; *l*, apical spine from first exopodite. The scale, referring to *a*, represents 1.0 mm.

FIGURE 14.—*Pygodelphys aquilonaris*, new species. *m–s*, Female: *m*, second leg; *n*, third leg; *o*, fourth leg; *p*, terminal segment of fourth exopodite; *q*, fourth endopodite; *r*, fifth leg; *s*, caudal ramus. *t–w*, Male: *t*, antennule; *u*, fourth exopodite; *v*, fourth endopodite; *w*, somites of fifth and sixth legs, right side. *x* Female of variant from *Boltenia villosa* habit, lateral view. *y*, *z*, *aa–ee*, Variant aspects of distal segments of antennules of specimens from various hosts: *y*, from *Pyura haustor; z*, from *Boltenia villosa; aa*, from *Halocynthia aurantium; bb*, from *Ascidia paratropa; cc*, from *Cnemidocarpa finmarkiensis; dd*, from *Styela gibbsii; ee*, from *Molgula* sp.

At the proximal third of the segment is inserted another reduced marginal seta. Curving over the surface of the distal portion of the segment toward the margin opposite that with the setae are two rows of fine spinules.

The mandible is much like that of *Notodelphys*. The masticatory plate (fig. 13,*e*) of the coxa is ornamented along the medial edge by five principal tooth-like projections, a saw-edge of fine, close-spaced denticles, and two fine, seta-like members. The basipodite (fig. 13,*f*) is long and slender. At the distal fourth of the medial margin is inserted one well-developed seta. The endopodite is bimerous. The subquadrate basal segment bears four setae, arranged as a row around the distal medial corner. The margins of the terminal segment are parallel, the length is about 1⅓ times the width, which is about half the greatest width of the basal segment. Nine setae form a close-set row along the distal three-fourths of the medial margin and across the terminal border. The exopodite is elongate and tapering. The segmentation is obsolete, apparently reduced to a bimerous condition. Five very long subequal setae are disposed along the ramus.

The protopodite of the maxillule (fig. 13,*g*) is elongate and rather narrow. The segmentation is obscure or obsolete. A small lateral protuberance, doubtless representing the epipodite, furnishes insertion for a long, stout, proximally directed seta and a short accessory setule. Medially there are two projections probably representing endites. The proximal endite is a greatly developed, flaring prominence bearing a row of nine masticatory setae closely set along the medial margin. Just distal to this endite is the slight prominence of the second, produced distally as an elongate, tapering, setiform structure. The distal portion of the protopodite is produced apically, turning the rami laterally. A trio of basipodal setae ornament the distal medial margin of the protopodite. The endopodite is somewhat hand-shaped and bears five setae disposed along the apical margin. Four long, stout, almost equal setae are arranged fan-like across the outer margin of the exopodite.

The pentamerous maxilla (fig. 13,*h*) is stout and compact. The massive basal segment is complicated medially by the production of the margin as four setiferous lobes, presumably the counterparts of endites. The basal prominence bears four setae. One is a reduced setule, the remaining three are long and stout, somewhat curved, and their bases are close-set in a compact row. The second prominence bears a single long straight seta. The third endite bears two equal setae. The fourth endite is well developed as an almost articulated

extension from the main mass of the segment and bears two equal setae. The second segment is produced medially as a tapered, curved, stout hook, bearing denticulations along the proximal edge. Two setae are inserted basally on the hook-process, the dimensions of one nearly double those of the other. The succeeding two segments are very slender. On the distal medial corner of each is inserted a well-developed seta. The apical segment is much reduced. Its ornamentation consists of an apical trio of subequal setae.

The bimerous maxilliped (fig. 13,*i*) is markedly slender and elongate. The basal segment bears setae arranged in two groups. Proximally, three setae are set close together along the margin and a fourth is inserted on the surface close to them. A quartet of setae is disposed around the distal medial corner and a large superficial seta is inserted on the surface near their bases. The distal margin of this segment is diagonal, so that the distal segment, which is articulated at the far lateral margin, is markedly subapically inserted. The distal segment is a truncated cone, its length about twice its greatest width. At the apex are inserted two long, subequal, plumose setae.

Swimming legs: The protopodites of the first legs (fig. 13,*j*) are somewhat elongated and inflated. The intercoxal plate is slightly reduced. Inserted on the medial distal corner of the coxa is a long slender seta which extends just beyond the distal border of the second segment of the endopodite. The basipodite is characterized by a very short lateral margin, near which is set a short seta, and a much longer medial margin. At the distal medial corner of the basis is articulated a stout, tapering, slightly curved spine which reaches well beyond the distal margin of the first segment of the endopodite.

The rami are trimerous. The large basal segment of the exopodite bears a long, stout, lateral spine and a well-developed medial seta. The second segment bears one much shorter, slighter, lateral spine (fig. 13,*k*) and a medial seta. The distal segment bears three lateral spines, an apical spine (fig. 13,*l*) and seta, and three medial setae. The dimensions of the spines of the distal segment are varied. The proximal spine is very short. The two distal spines are slender but elongate. The three more proximal spines of the ramus are distinguished by the possession of thin, transparent, serrated, marginal flanges.

The endopodite tapers somewhat from a distinctly thickened basal segment. The first two segments each bear a single medial seta. The terminal segment bears three medial setae, two apical setae, and a single seta inserted about midway on the lateral margin. Fine spinules form short rows, which ornament each of the segments of the endopodite and the basipodite near its medial spine, and a fine serration along the lateral margin of the first segment of the exopodite.

The protopodites of the second legs (fig. 14,*m*) are very long in proportion to width. The coxae are linked by a much-reduced intercoxal plate. At the distal medial corner of each coxa is inserted a slender seta which reaches to the distal margin of the first segment of the endopodite. The only ornamentation of the basipodite is a reduced seta inserted near the short lateral margin.

The trimerous exopodite is slender and elongate. All the elements of the armature are setiform. Each of the two basal segments bears a lateral seta and a medial seta. The distal segment bears three lateral setae, graduated somewhat in length, two apical setae, and four medial setae.

The endopodite is bimerous. The elongate second segment exhibits a most distinctive outline produced by strong medial emarginations into which the setae are inserted. The basal segment bears a single medial seta. The distal segment bears five medial setae, two apical setae, and a lateral seta inserted at the distal third.

The third legs (fig. 14,*n*) are much elongate and narrowed. The coxopodites are more or less rectangular and they are united by a much-reduced intercoxal plate. At the distal medial corner of the coxa is inserted a slight seta which does not quite reach the distal margin of the first segment of the endopodite. The armature of the basipodite consists of a single reduced seta inserted near the short lateral margin.

The basal segment of the trimerous exopodite is much elongated, nearly equaling the combined lengths of the two distal segments. The second segment is slightly prolonged, subquadrate. The distal segment is elongate and slightly tapered. All the elements of the armature are setiform.

The basal segment bears a short rigid lateral seta and a short medial seta about twice as long. The second segment bears a lateral seta and a medial seta. The terminal segment bears three lateral setae, two apical setae, and four medial setae.

The bimerous endopodite is elongate, mainly due to the pronounced extension of the second segment, which is 2½ times as long as the basal segment. Both segments are relatively slender, the basal segment being about as long as wide. The first segment bears a single medial seta. The terminal segment bears five medial setae, two apical setae, and a lateral seta inserted at the distal fifth.

The protopodites of the fourth legs (fig. 14,*o*) are much elongate and slightly tapered to a somewhat conical aspect. The coxae are united at their basal third by a rudimentary intercoxal plate. At the distal medial corner of the coxa is inserted a small seta which extends

just beyond the midpoint of the basal segment of the endopodite. Inserted near the very short lateral margin of the basipodite is a short, much-reduced seta.

The basal segment of the elongate, trimerous exopodite approaches the combined lengths of the two distal segments, each of which is also markedly produced. All elements of the armature are setiform. The basal segment bears a short, lateral seta and a medial seta. The second segment bears a lateral seta and a medial seta. The terminal segment (fig. 14,*p*) bears two lateral setae, two apical setae, and four medial setae.

The bimerous endopodite (fig. 14,*q*) is markedly elongate, its apex reaching the level of the midpoint of the terminal segment of the exopodite. The basal segment is about as long as its greatest width and it bears a medial seta. The outline of the somewhat tapered second segment, which is 3½ times as long as the basal segment, is characterized by pronounced emarginations accommodating the insertions of lateral and medial marginal setae. There are four medial setae, two apical setae, and one lateral seta.

Vestigial legs and caudal rami: The fifth legs (fig. 14,*r*) are much reduced, with segmentation obsolete. Each consists essentially of a short plate with widely separated lateral and medial short prolongations. At the apex of each prolongation is inserted a short, slender seta. The lateral prominence is somewhat complicated basally, presenting slight evidence that it might represent the vestige of the distal segment characteristic of this appendage in most notodelphyids.

The caudal rami (fig. 14,*s*) are long, gently tapered, and somewhat flattened. The length is about five times the basal width. The integument of the rami is fairly heavily sclerotized. The armature is well developed. Three setae are inserted across the apex. Two of these are subequal and slightly exceed the length of the ramus. The third is half as long as these. Two setae are inserted in lateral emarginations. One, at the proximal fourth, is about three-fourths as long as the ramus. The other, at the distal fifth, is nearly as long as the ramus. A very short seta is inserted on the dorsal surface, toward the medial margin, at the distal eighth.

Male (fig. 14,*t–w*): The body is much smaller and slenderer than in the female. The metasome is 4-segmented. The urosome is 6-segmented. The caudal rami are slender and bear much more highly developed setae.

In the antennule (fig. 14,*t*) the terminal segments are coalesced and the second segment bears a short, stout hook-seta.

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The swimming legs are much more generalized than in the female. The armature of the posterior exopodites (fig. 14,*u*) includes well-developed spines.

The posterior endopodites (fig. 14,*v*) are trimerous and the segments are not nearly so elongate.

The fifth and sixth legs (fig. 14,*w*) are markedly similar in structure. In each, two setiferous lobes are borne at the end of the appropriate thoracic somite.

Remarks: This species shows a considerable range of variation, as might be expected of so widespread and tolerant a form. Several structural features seem constant for representatives from specific hosts. The variants are not considered sufficiently demarcated to warrant taxonomic designation at the present stage of knowledge of the group. The description above is drawn from the holotype, which is associated with *Pyura haustor*. This form is also that considered in drawing up the key to the species above. When the full range of variation of North American representatives is accounted for in a description, it is impossible to separate this from the very generalized published description of *P. lamellipes* (Schellenberg). However, since many specific details of the latter species have not received full treatment, it seems undesirable to give the northern specimens this specific name.

The variant types from Washington show a number of distinctive features. Specimens from *Boltenia villosa* (fig. 14,*x*) present a characteristic silhouette, due to posterior prolongation of the dorsal margins of thoracic somites to present the appearance of a series of spikes.

The terminal segments of the antennule vary in their proportions. The typical form from *Pyura haustor* has subquadrate terminal segments with spinulose ornamentation (fig. 14,*y*). Specimens from *Boltenia villosa* (fig. 14,*z*), *Halocynthia aurantium* (fig. 14,*aa*), *Ascidia paratropa* (fig. 14,*bb*), *Cnemidocarpa finmarkiensis* (fig. 14,*cc*), *Styela gibbsii* (fig. 14,*dd*), and *Molgula* sp. (fig. 14,*ee*) are figured to show the corresponding variations.

### Genus *Pachypygus* Sars

*Doropygus* Thorell, 1859a, p. 52 (part).

Doropygus (*Notopterophorus*) Giesbrecht, 1882a, p. 294 (part).—Canu, 1892, p. 191.

*Notopterophorus* Schimkewitsch, 1893, p. 200 (part).—Schellenberg, 1922, p. 254.

*Notopterophorus* (*Doropygus*), Allen and Todd, 1902, p. 316 (part).

*Pachypygus* G. Sars, 1921, p. 51 (type species, by monotypy, *Doropygus gibber* Thorell, 1859).

This genus, proposed by G. Sars (1921), is well delimited but has retained its monotypic status to date. However, the American repre-

sentatives available have sufficiently characteristic features that it seems desirable at this time to emphasize the fact by proposing specific status for them. There is no outstanding distinction in setation, but there are sufficient minor deviations in detail to indicate a genetic separation. The diagnosis of the genus thus is not altered.

The body is invested with a heavily sclerotized integument which emphasizes the marked compression. The pentamerous metasome consists of a large cephalosome and four free thoracic somites, very unequal in size, with the first minute and the third much enlarged; a greatly expanded brood sack occupies most of the posteriormost segment. The urosome is 6-segmented and bears the somite of the fifth legs. The reduced perianal ring upon which the caudal rami are inserted is counted as the sixth segment.

The antennule is 7-segmented, with marked basal expansion. The setation of the trimerous antenna is much reduced. The endopodite of the mandible tends toward reduction, with accompanying diminution of the setae both in number and proportion. In the exopodite segmentation is suppressed so that the ramus becomes a rigid flat plate bearing well-developed setae.

The maxillule is characterized by the indistinctly bimerous endopodite, with profuse setation. The well-developed exopodite bears four strong setae. The second segment of the tetramerous maxilla bears an extremely heavy, prehensile claw-process. The setation of this appendage is relatively reduced. The maxilliped is trimerous, with all segments setiferous. The basal segment bears about eight setae, the second segment one seta, and the terminal segment four setae.

The swimming legs are marked by a strong tendency to reduction of setation. The first legs are not particularly distinctive, but in the succeeding three pairs the setae of the exopodites tend toward obsolescence or are absent. The fifth legs are generalized, and, except for their heavy sclerotization, conform well to the usual type found in *Doropygus*.

The caudal rami are highly sclerotized. They taper strongly from expanded bases. The terminal armature consists of a number of short, stout, curved claws rather than setae.

Key to the species of *Pachypygus*, based upon females

1*a*. Medial margin of third segment of fourth exopodite straight and unornamented . . . . . **macer**, p. 610

1*b*. Medial margin of third segment of fourth exopodite sinuate, set with spinules . . . . . **gibber**, p. 610

NORTH AMERICAN SPECIES

### ?*Pachypygus gibber* (Thorell)

*Doropygus gibber* Thorell, 1859a, pp. 52–53, pl. 8, fig. 11 (type locality, Swedish coast, in *Ascidia intestinalis*); 1859b, pp. 339, 343; 1860, pp. 118–119, 123.—Hesse, 1866, pp. 63–64.—Buchholz, 1869, pp. 120–122, pl. 7, fig. 4.—Gerstaecker, 1870–1871, pp. 775–777, 792, 801.—Kerschner, 1879, pp. 186–187, pl. 1, figs. 5–7; pl. 2, fig. 6; pl. 3, figs. 2, 5–8; pl. 6, figs. 3–9.—Richiardi, 1880, p. 147.—Aurivillius, 1882a, p. 56, pl. 6, figs. 11, 12; 1882b, p. 112; 1883, pp. 26, 108, pl. 2, figs. 11, 12.—Koehler, 1890, pp. 137–138, fig. 10.—Canu, 1891, p. 472.—Thompson, 1893, p. 190, pl. 18, fig. 2.—Brian, 1898, p. 9.—T. Scott, 1900, p. 386; 1907, p. 364.—Graeffe, 1902, p. 39.—Stephensen, 1913, p. 349.—Chatton and Brément, 1915c, pp. 147–149, fig. 2.—Wilson, 1920, p. 14.—Gurney, 1933, p. 304.

*Doropygus* (*Notopterophorus*) *gibber*, Giesbrecht, 1882a, pp. 294, 317, 328.—Carus, 1885, p. 343.—Canu, 1892, pp. 191–193, pl. 5, figs. 25–31; pl. 6, figs. 1–8; pl. 7, figs. 1–10.—Pesta, 1909, pp. 258–262, pl. 1, figs. 1–6.

*Notopterophorus gibber*, Schimkewitsch, 1893, pp. 200–203; 1896, p. 339, pl. 14, figs. 33, 39–42, 47–52, pl. 16, figs. 53–55, 57–60.—Norman, 1905, p. 36.—Norman and Scott, 1906, p. 202.—Hartmeyer, 1911, p. 1735.—Schellenberg, 1922, pp. 254, 267.—Harant, 1931, p. 372.—Pesta, 1934, p. 8.—Sewell, 1949, p. 182.

*Notopterophorus* (*Doropygus*) *gibber*, Allen and Todd, 1902, pp. 316, 325.

*Pachypygus gibber*, G. Sars, 1921, pp. 51–52, pl. 25.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 120, fig. 71.—Lang, 1948, p. 3.—Sewell, 1949, pp. 182, 188.

DISTRIBUTION: Mediterranean to Norway and Sweden; British Isles; (?)Greenland; (?)Australia.

HOSTS: *Ascidia canina*, *A. glabra* Hartmr., *A. intestinalis*, *A. plebeia*, *A. venosa*, *Boltenia bolteni*, *Clavelina lepadiformis* Müll., *Clavellina* sp., *Cynthia microcosmus*, *Molgula ampulloides* Beneden, *M. oculata* Forb., *M. socialis* Alder, *Phallusia* cf. *cristata*, *P. fumigata* Grube, *P. obliqua*, *P. patula*, *P. virginea*, *Polycarpa comata* (Ald.), *P. gracilis* Hell.

REMARKS: A report by Vanhöffen (1897, p. 292) of this species from Greenland has been shown by Hansen (1923, p. 26) to be based upon a misidentification of *Schizoproctus inflatus*. Whether Hansen's additional record of a specimen from Greenland is referable to this species or to *P. macer* will have to be decided by reference to the original specimen, if it can be located.

### *Pachypygus macer*, new species

FIGURE 15

*Pachypygus gibber*, Wilson, 1927, p. 162.

TYPES: Holotypic female, USNM 92798 (type locality, Hurricane Harbor, Miami, Fla., in *Styela plicata* Lesueur), and paratypes listed below.

SPECIMENS EXAMINED:

FLORIDA

From *S. plicata:*

Hurricane Harbor, Miami, from test block, Mar. 23, 1950, L. B. Isham, holotype.

From solitary ascidian:

Gulf of Mexico, 3½ miles southwest of Longboat Pass, Sarasota Bay, Feb. 28, 1951, J. B. Knight, 1 female.

From *Microcosmus exasperatus* Heller:

Sanibel Island, Stewart Springer, 2 females.

SOUTH AMERICA

From *M. exasperatus:*

Spanish Water, Curaçao, 1920, C. J. van der Horst, 5 females.

DESCRIPTION: Female (fig. 15,*a–n*): General features: The body (fig. 15,*a*) is much compressed but with an inflated outline approaching an ovoid. This aspect is primarily that of the metasome, which much exceeds the urosome. The metasome is pentamerous, with a moderate sized head, a small thoracic segment bearing the first legs, a larger segment bearing the second legs, a much larger segment bearing third legs, and a much-expanded fourth segment which accommodates the brood sack. The urosome is 6-segmented and includes the somite of the fifth legs.

A well-developed rostrum protrudes anteriorly and ventrally between the bases of the antennules.

Head appendages: The antennule (fig. 15,*b*) is 9-segmented, with a complicated articulation at the ventral surface of the head. The proximal two segments are subequal, each is elongate and inflated, so that the combined length of the two considerably exceeds the combined length of the terminal seven segments. The second segment is longer than the first. At its distal border the ventral margin considerably projects beyond the base of the third segment producing the characteristic aspect of enveloping it. The width of the second segment at its distal margin is nearly twice the greatest width of the third segment. The third segment also presents the effect of slightly enveloping the base of the slightly narrower fourth segment. The seven terminal segments form a tapered assemblage, each in linear order slightly narrower than the preceding. The lengths are in approximately serial order also, except that the fifth segment is slightly longer than the fourth. The setae of the antennule are short and slender and the ciliation is diminished to lacking.

The antenna (fig. 15,*c*) is distinctly 3-segmented. The basal segment is the longest; the second segment the shortest. All segments are heavily sclerotized. The terminal hook is relatively long, slender and taperingly acuminate. The two proximal segments bear no setae. The terminal segment is ornamented with several short,

FIGURE 15.—*Pachypygus macer*, new species, female: *a*, habit, lateral view; *b*, antennule; *c*, antenna; *d*, masticatory lamella of mandible; *e*, palp of mandible; *f*, maxillule; *g*, maxilla; *h*, maxilliped; *i*, first leg; *j*, second leg; *k*, third leg; *l*, fourth leg; *m*, fifth leg; *n*, caudal rami. The scale, referring to *a*, represents 1.0 mm.

slender setae. Four setae are set near the articulating region of the terminal claw. A more proximal trio of setae is closely adherent to one of the flattened surfaces of the segment. Two isolated setae are more basally placed on the segment.

The mandible is well developed. The masticatory portion is illustrated (fig. 15,*d*). The palp (fig. 15,*e*) bears a complement of profusely plumose setae. The exopodite is a heavily sclerotized flattened plate with all evidence of segmentation suppressed. The five subequal, plumose setae are long and stout and arranged in a fan-like row on the lateral margin. The basipodite bears a long, stout, plumose seta inserted on the medial margin at a point about opposite to the lateral articulation of the exopodite. The terminal endopodite is 2-segmented. The basal segment is the shorter, but is the wider. It bears a medial row of four plumose setae, all well developed. The terminal segment bears a medial row of four setae, a medial distal pair of subequal setae, and a distolateral trio, consisting of two approximately equal, shorter setae, and a much stouter and longer seta at the lateral angle. All the setae are plumose.

The maxillule (fig. 15,*f*) has a well-developed protopodite, monomerous exopodite, and bimerous endopodite. The masticatory endite bears a medial row of about ten relatively short, stout, tapered setae. The next proximal endite supports a seta-like outgrowth of very much the same dimensions as the stoutest of the masticatory row of setae. The anatomically medial trio of setae of the basipodite are borne almost terminally on the appendage. The proximal seta of this group is much the longest and stoutest. The distal two setae are of about half the length and thickness of the accompanying seta. The endopodite is distinctly 2-segmented. The basal segment has a medial row of short, slender setae. There is a terminal trio of subequal longer, stouter setae on the very short distal segment. The exopodite widens sharply from a constricted articulation to a broadly truncate distal margin. Four subequal, long, stout setae are set along this margin. The epipodite supports a long, stout, tapering seta, accompanied by a very short, spike-like, plumose spinule or setule. All the setae of the appendage are plumose.

The maxilla (fig. 15,*g*) is 5-segmented. The terminal four segments are much inclined as a distal unit upon the much longer, stouter basal segment. The terminal three segments are slender and the fourth is much the longest of this distal trio. The setation of the appendage is generalized. The basal segment is ornamented by a basal quartet of setae set upon the prominent proximal protuberance. There are arranged successively a single seta and two couples of setae all borne on less conspicuous protuberances. The distal medial margin of the

second segment is much produced, flaring into the base of its heavy claw. The claw is accompanied by a long, plumose seta and a very short setule. The third segment supports a long, plumose seta at the distal medial corner. The armature of the fourth segment is a single distal, medial, long, plumose seta. The very short terminal segment bears four subequal setae, two of these seemingly terminal. The setae of the appendage are richly plumose.

The maxilliped (fig. 15,*h*) is 3-segmented. The basal segment is very long and slender. It bears medially a more basal quartet and a distal quintet of slender masticatory setae. The long, stout second segment bears one medial seta, relatively long and slender. The distal segment is the shortest and slenderest. It bears a medial row of three long setae and a distal, short, much-tapered seta. All the setae are plumose.

The first legs (fig. 15,*i*) are generalized. The intercoxal plate is tapering, with a resultant truncated triangular aspect. The medial coxal seta is long, reaching as far as the tip of the endopodite. The basipodite bears a lateral seta which approximately equals in length the basal segment of the exopodite. The medial spine of the basipodite is stout and tapered. It reaches about to the middle of the second segment of the endopodite. The spines of the exopodite are approximately serially graduated in length and of about the same stoutness. The exopodite is linear with little flexure of the segments upon one another. The two basal segments each bear a lateral spine and a medial seta. The distal segment bears three lateral spines, an apical spine and seta, and three medial setae.

The two proximal segments of the trimerous endopodite each bear a medial seta. The distal segment bears three medial setae, two apical setae, and a lateral seta.

The second legs (fig. 15,*j*) are modified. There is no intercoxal plate. There is a medium-long medial coxal seta. The lateral seta of the basipodite is short and slender. The endopodite is linear and the ornamentation is of generalized type. The exopodite is longer than the endopodite. It is flattened and fairly heavily sclerotized. Its spines have a characteristic short, straight, blunted aspect. Only the basal segment bears a seta, which is normally long and plumose. The basal segment also bears a heavy, short spine. The second segment bears only a similar spine. The third segment bears three short stout lateral spines and an apical spine about twice as long as the lateral members. The medial margins of the segments are linear and heavily sclerotized.

The ornamentation of the endopodite consists of one medial seta on the basal segment, two medial setae on the second segment, and

three medial setae, two apical setae, and one lateral seta on the distal segment.

The third legs (fig. 15,*k*) show the same trend of modification as do the second but with the more extreme aspect of complete lack of setae on the exopodite segments.

The two basal segments of the exopodite each bear a lateral spine. The distal segment bears three lateral spines and an apical spine. The medial margins of the two distal segments form almost a continuous, heavily sclerotized line.

The fourth legs (fig. 15,*l*) are also consistently specialized. The bimerous protopodite is expanded and inflated, with ornamentation obsolete.

The trimerous exopodite is conspicuously slender and elongate. It lacks setae entirely. The two basal segments bear each a stout lateral spine. The terminal segment bears three lateral spines and an apical spine. The medial margins of the segments are straight, uninterrupted, and heavily sclerotized.

The ornamentation of the trimerous endopodite consists of one medial seta on the basal segment; two medial setae on the second segment; and two medial setae, one apical seta, and two lateral setae on the distal segment.

The uniramous fifth legs (fig. 15,*m*) are heavily sclerotized. The long basal segment is relatively narrow and fairly markedly set off from the body somite. It bears a distal, medial, short, slender seta. The distal segment is about a quarter again as long as the basis. The armature is a medial distal seta and a thornlike spine toward the lateral corner. The lateral margin is indented with a characteristic sclerotized flange projecting distally beyond each point of indentation. The length of the segment is about 3½ times its greatest width.

The caudal rami (fig. 15,*n*) are very slender in proportion to their length, the ratio of greatest width to over-all length being 1: 5. They exhibit a rather slight taper, further, with the basal width only about twice the apical width. The armature consists of four subequal, short spines, apically inserted, and a seta placed on the lateral margin three-fifths of the length of this margin from its base.

No male specimen has been found.

Remarks: This species is differentiated from *Pachypygus gibber* on the grounds of considerably less expanded development of various of the appendages. The body outline does not tend to so extreme a degree of exaggerated inflation. The urosome is a much slenderer cylinder with the middle segments tending to be somewhat longer than wide. The caudal rami are particularly slender in comparison with the older species.

The segments of the posterior swimming legs are much more produced in *P. macer*, and the inner margins of the terminal segments of the exopodites are linear and unornamented rather than sinuate and weakly spinose.

### *Pomphopygus*, new genus

The genus is monotypic, with *Pomphopygus pinguis*, new species, described below, the type species. The specific description will also serve for the characterization of the genus, as it is so far known.

#### *Pomphopygus pinguis*, new species

FIGURE 16

TYPES: Holotypic female, USNM 92808 (type locality, Channel Islands, Calif., in *Ascidia clementea* Ritter), and paratypic females.

SPECIMENS EXAMINED:

CALIFORNIA

From *A. clementea:*

Off San Nicolas Island, dredged, 1904, U. S. Fish Commission Steamer *Albatross*, Station 5582, female types.

Off San Clemente Island, dredged in 659–704 fms., Apr. 9, 1904, U. S. Fish Commission Steamer *Albatross*, Station 4405, 1 female.

DESCRIPTION: Female (fig. 16,*a–p*): General features: The body (fig. 16,*a*) is much inflated with very lightly sclerotized integument. A fine fur of light ciliation covers most of the body. The general effect of the appearance in preserved specimens is that characterizing the hyperiid amphipods, combining transparency and sparseness of internal structure.

The metasome consists of a head complex, three free thoracic somites, and the greatly inflated incubatory segment.

The segmentation of the urosome has been impossible to establish accurately from the specimens available. The characteristics of texture mentioned above combined with the effects of poor preservation have brought about obscuring of surface texturing which would indicate the anatomical subdivisions. The caudal rami are unique among those of notodelphyids I have studied in their ballonlike quality. The usual slight degree of sclerotized rigidity here is seemingly lacking.

Head appendages: The 9-segmented antennule (fig. 16,*b*) is much like that in *Doropygus* but with reduced setation. The three basal segments form a fairly sharp taper. The six distal segments taper only gradually to the apex. The two most proximal segments are massive and much expanded. The distal portion of the third segment envelops nearly a half of the fourth segment. All the setae are

relatively weak and short. An approximation of the number present by segments is: 1–2; 2–5; 3–4; 4–3; 5–2; 6–3; 7–1; 8–1; 9–6.

The trimerous antenna (fig. 16,*c*) is stout with a weak terminal segment. The basal segment is longest, about twice as long as wide. The second segment is shortest. The third segment is markedly narrower than the second. It is about twice as long as wide; articulated at its apex is a weakly developed, curved, tapered prehensile claw. Four setae are inserted near the articulation of the claw. A very reduced seta is set at about the midpoint of the outer margin of the segment.

The mandible consists of a bimerous protopodite and two rami. The coxopodite is extended medially as a well-developed masticatory lamella (fig. 16,*d*). The serrations of the inner margin of the lamella are differentiated into five stout toothlike projections, a finely denticulate region, and two setiform processes. The basipodite (fig. 16,*e*) bears a single well-developed seta, inserted about midway on the medial margin.

The endopodite is bimerous; the first segment is much smaller than the second. A single seta is inserted on the medial margin of the basal segment. The distal segment bears six setae, three distributed along the medial margin, two apical, and one on the lateral margin. The setae are subequal and the longest and stoutest of them are still actually reduced.

The exopodite is a flattened, broadly ovate, platelike structure. The five nearly equal setae are all well developed, long and stout, and arranged nearly regularly around the outer circumference of the ramus.

The maxillule (fig. 16,*f*) is characterized by suppression of the rami and distal portion of the protopodite and exaggeration in bulk of the proximal portion of the protopodite. The single endite is greatly produced medially and bears along the inner margin six closely set, stout, stiff, masticatory setae. Inserted on the basal portion including this endite is the remainder of the appendage compressed to a palplike structure. Laterally at the base is borne a long, slender, proximally directed seta representing the epipodite. Just distal to this a projection bearing four equal setae represents the exopodite in which the articulation with the segment has been almost completely suppressed. An apical prominence bears three terminal setae and two medial setae. The anatomical explanation of this structure would assign the two medial setae to the basipodite and the three terminal setae to the endopodite with the articulation again having been suppressed to near obsolescence.

The tetramerous maxilla (fig. 16,*g*) is marked by great inflation proximally and some suppression of armature. The basal segment

FIGURE 16.—*Pomphopygus pinguis*, new species, female: *a*, habit, lateral view; *b*, antennule; *c*, antenna; *d*, masticatory lamella of mandible; *e*, palp of mandible; *f*, maxillule; *g*, maxilla; *h*, maxilliped; *i*, first leg; *j*, second leg; *k*, protopodite and endopodite of third leg; *l*, third exopodite; *m*, protopodite and exopodite of fourth leg; *n*, fourth endopodite; *o*, fifth leg; *p*, caudal ramus. The scale, referring to *a*, represents 0.5 mm.

bears only three endites, the first one set with four setae and each of the two more distal ones bearing two approximately equal setae.

The second segment is well developed and produced medially as a very stout, heavily sclerotized hook or claw. Basally inserted on the claw-process is one equally long, well-developed seta and an accompanying reduced setule. The third segment bears a single seta inserted at the distal medial corner. The minute fourth segment bears three well-developed apical setae.

The maxilliped (fig. 16,*h*) is a reduced flattened plate with weakly sclerotized integument. Five fairly stout setae are grouped along the medial margin. A single seta is inserted at the distal lateral corner.

Swimming legs: The first legs (fig. 16,*i*) are composed of 2-segmented protopodites and trimerous rami. The coxopodites are yoked together by an intercoxal plate. The medial coxal seta of most notodelphyid genera is here absent. Inserted near the lateral margin of the basipodite is a short seta. Inserted distally and medially on the basipodite is a relatively stout spine which extends to near the distal margin of the second segment of the endopodite.

The basal segment of the exopodite is much the largest. It bears a lateral spine and medial seta. The second segment bears a lateral spine and medial seta. The distal segment bears two lateral spines, an apical spine and seta, and three medial setae, a distinctive ornamentation.

The two basal segments of the endopodite are short; their combined lengths are exceeded by that of the distal segment. Each of the two basal segments bears a single medial seta. The terminal segment bears two medial setae, two apical setae, and two lateral setae.

The setae of the rami are relatively short and slender and only feebly ciliated.

The second legs (fig. 16,*j*) are of small size and exhibit some reduction in structure. The bimerous protopodites lack armature and no intercoxal plate is present.

The exopodite is trimerous with the segments somewhat elongated in proportion to width. The basal segment, which is much the longest, and the second segment bear each a lateral spine and a medial seta. The third segment bears three lateral spines, an apical spine and seta, and four medial setae.

The endopodite is much smaller than the exopodite. The segments are progressively lengthened, so that the second is about twice as long as the first and the length of the third about equals the combined lengths of the two basal segments. The first and second segments bear each a medial seta. The third segment bears two medial setae, two apical setae, and two lateral setae. The setae of both rami are

short and slender and the usual plumose ciliation is here reduced or absent.

The somewhat reduced third legs (fig. 16,*k*,*l*) consist of bimerous protopodites and bimerous rami. Coxopodite and basipodite lack armature and there is no intercoxal plate.

The two proximal segments of the exopodite (fig. 16,*l*) bear each a lateral spine and medial seta. The terminal segment bears three lateral spines, an apical spine and seta, and four medial setae.

The endopodite is much smaller in bulk than the exopodite and slenderly linear in outline. The basal segment is much the smallest. The two subequal distal segments are each about twice as long as the basal segment. Each of the two proximal segments bears a single seta inserted at the distal medial corner. The distal segment bears two medial setae, two apical setae, and two lateral setae. All the setae of both rami are slender and with the usual plumose ciliation scant or absent.

The bimerous protopodites of the fourth legs (fig. 16,*m*) lack ornamentation and there is no intercoxal plate.

The two basal segments of the trimerous exopodite bear each a lateral spine and medial seta. The distal segment bears three equal lateral spines, an apical spine and seta, and four medial setae.

The trimerous endopodite (fig. 16,*n*) is slender and linear in outline and much exceeded in mass by the exopodite. The basal segment is much the shortest, equaling in length only about half that of either of the two subequal distal segments. The two proximal segments each bear a single seta inserted at the distal medial corner. The distal segment bears two medial setae, two apical setae, and a single lateral seta. None of the setae of the rami are ciliated.

Vestigial legs and caudal rami: The fifth legs (fig. 16,*o*) are reduced to thin scalelike plates lacking ornamentation.

The lengths of the caudal rami (fig. 16,*p*) are about three times the greatest width. The integument is very lightly sclerotized and distinguished by a profuse fine ciliation. Four subequal reduced setae are inserted at the apex. A fifth seta is inserted at the proximal third of the lateral margin.

No male specimen was found.

Remarks: The characteristics of this copepod do not permit its inclusion in any of the previously known genera. In many ways it appears to be a transitional form between the genera with less modified habitus, like *Doropygus*, and exaggeratedly specialized examples, like *Gunenotophorus*. The suppression of the palp portions of the mandible and maxillule bear out the resemblance to *Gunenotophorus*, as do the reduced maxillipeds. The swimming legs are somewhat like those in *Doropygus*, but they are considerably reduced. The absence of a

medial coxal seta on the first legs and the armature of the terminal segment of the first exopodite are features most rarely encountered among the notodelphyids. The degree of reduction of the fifth legs is also an unique feature among the series of forms in which this species seems to have its closest allies.

### Genus *Gunenotophorus* Buchholz

*Gunenotophorus* (nomen nudum), Costa, 1840, p. 7.—Hope, 1851, p. 37.—Leuckart, 1859, p. 242.—Thorell, 1859a, p. 6; 1859b, p. 336; 1860, p. 115.—Claus, 1864, pp. 381–382.

*Sphaeronotus* Claus, 1864, p. 379 (not *Sphaeronotus* Laporte, 1832) (type species, by monotypy, *S. thorellii* Claus, 1864).

*Gunentophorus* Buchholz, 1869, p. 144 (type species, by monotypy, *G. globularis* Buchholz, 1869).—Gerstaecker, 1870–1871, p. 719.—Claus, 1875, p. 350.—Kerschner, 1879, p. 190.—Aurivillius, 1883, p. 26.—Carus, 1885, p. 344.—Brehm, 1927, p. 490.—G. Sars, 1921, pp. 56–57.—Wilson, 1924, p. 21; 1932, p. 602.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 121.—Lang, 1948, p. 3.—Sewell, 1949, p. 170.

*Gynentophorus* von Martens, 1879, p. 44.

*Gunenotophorus* Giesbrecht, 1882a, pp. 325, 326.—Canu, 1891, p. 475; 1892, p. 199.—Brian, 1905, p. 3; 1906, p. 144.—T. Scott, 1907, p. 366.—Stebbing, 1910, p. 550.—Schellenberg, 1922, pp. 257–258.

*Gunentopherus* Koehler, 1890, p. 138.

*Gunenthophorus* Graeffe, 1902, p. 40.

*Gunetotrophus* Norman, 1905, p. 36.

*Guenenotophorus* Harant, 1931, p. 371.

*Doropygus* Pearse, 1952, p. 189 (part).

The name *Gunenotophorus* was first published as an item in the specific catalog of Costa (1840, p. 7). This was a nomen nudum, and as such has been recorded by all the principal nomenclators. Accompanying this genus in the list was *Notopterophorus*, with two species, *N. elongatus* and *N. elatus*. These terms were also nomina nuda. In 1852 a set of plates illustrating entomostracans was published in Costa's same series and included as one of two designated "plate 2," a group of figures of copepods. There was no explanation of these figures ever issued. Not all sets of Costa's work include this plate. I have not been able to locate it in several sets consulted in the United States. However, several European authors refer to it. Among the figures are recognizable depictions of previously named species. For some of the remaining figures, authors have been unanimous in their acceptance that the illustrated features are recognizably attributable to the concept of a "notopterophorus." The figures left, by exclusion, are available as the illustration of the only unillustrated name on Costa's list, *Gunenotophorus globularis*.

Hope (1851) repeated Costa's listing of species, with the only additional information a mention of Sicily as the locality. Leuckart (1859) described a species of *Notopterophorus* and accepted Costa's

designation of the genus, referring to the list and to the figure. He also mentioned Costa's usage of *Gunenotophorus*, and stated that some of the figures of the plate perhaps refer to this name. Thorell (1859a, p. 6) referred to Costa, Hope, and Leuckart, and stated that Costa, on "plate 2," illustrated two crustaceans named *Gunenotophorus* and *Notopterophorus*. Thorell's statements were repeated in his references of 1859b and 1860.

Claus (1864, pp. 381–382), in his full description of *Sphaeronotus thorellii*, remarked that figures 1–3 of Costà would possibly apply to *Sphaeronotus*, in which case he assumed Costa's *Gunenotophorus* was the same as his genus.

Buchholz (1869) described and figured *Gunentophorus globularis*, attributing the authorship to Costa. Brian (1905, p. 3) described specimens from the Costa collections that came from Messina. It is possible that these were the animals upon which the original reference and figures were based.

It is clear that Costa's name was a nomen nudum and no one of the later workers, until Buchholz (1869), definitely established the connection of name, illustration, and organism. However, Claus' prior description of the species concerned as *Sphaeronotus thorellii* has precedence. Since *Sphaeronotus* Claus was preoccupied, the present genus is attributed to Buchholz (1869), emending his spelling.

The genus *Gunenotophorus* is a markedly coherent one, doubtless due to the small number of known forms. These are among the most massive of the notodelphyids, exhibiting a great inflation of the incubatory cavity.

The urosome is nearly normally developed, but the segmentation is partially obsolete. The caudal rami are so modified that seemingly they perform a prehensile function.

The head appendages are much specialized. The segmentation of the antennule is reduced and the structure is inflated. In most of the remaining head appendages the segmentation shows marked suppression and the ornamentation is variously reduced.

The first legs are unique in the expansions of the exopodites. The second to fourth swimming legs are also unlike those of any other notodelphyid. The exopodites are elongated and inflated, and the armature is obsolete to lacking. The endopodites are modified into members with no strictly comparable counterparts in other genera. Fifth legs are lacking. The male has not yet been described.

Schellenberg (1922) described a new species in the genus and also proposed a variety in *G. globularis*, var. *giganteus*. In view of the small amount of information generally available on anatomic variation in notodelphyids and of the distinctive character by which Schellenberg's variety is diagnosed, it is proposed to assign the form

specific status. By the addition of the new species described below, *Gunenotophorus* then includes four species, which may be separated in the following key.

### Key to the species of *Gunenotophorus* based upon females

1*a*. Inner margin of terminal segment of second exopodite with row of prominent spines . . . . . **spinipes** (p. 623)

1*b*. Inner margin of terminal segment of second exopodite without prominent spines . . . . . 2

2*a*. Second exopodite thick and about one-third longer than second endopodite . . . . . **giganteus** (p. 623)

2*b*. Second exopodite at least twice as long as the endopodite. . . . . 3

3*a*. Terminal segment of second exopodite straight . . . . **globularis** (p. 623)

3*b*. Terminal segment of second exopodite markedly curved . . **curvipes** (p. 629)

#### Species not Known from North America

#### *Gunenotophorus giganteus* Schellenberg

*Gunenotophorus globularis* Costa, var. *giganteus* Schellenberg, 1922, p. 258, fig. 39 (type locality, South Africa, in *Pyura stolonifera* (Hell.)).

Distribution: South Africa.

Host: *Pyura stolonifera* (Hell.).

#### *Gunenotophorus spinipes* Schellenberg

*Gunenotophorus spinipes* Schellenberg, 1922, pp. 258–259, fig. 40 (type locality, Straits of Magellan, in *Alloeocarpa emilionis* Michaelsen and *Polyzoa coccinea* (Cun.)).

Distribution: Straits of Magellan.

Hosts: *Alloeocarpa emilionis* Mchlsn. and *Polyzoa coccinea* (Cun.).

#### North American Species

#### *Gunenotophorus globularis* Buchholz

Figure 17,*a*

*Gunenotophorus globularis* (nomem nudum), Costa, 1840, p. 7.—Hope, 1851, p. 37.—Leuckart, 1859, p. 242.—Claus, 1864, pp. 381–382.

*Sphaeronotus thorellii* Claus, 1864, pp. 379–382, pl. 36, figs. 29–34 (type locality, Naples, in ascidians).

*Gunentophorus globularis* Buchholz, 1869, pp. 144–149, pl. 10, fig. 8 (type locality, Naples, in *Cynthia ?microcosmus*).—Kerschner, 1879, pp. 190–192, pl. 2, fig. 3, pl. 6, figs. 17–28.—Gerstaecker, 1870–1871, pp. 775, 804.—Aurivillius, 1882a, pp. 56–58; 1882b, pp. 70, 112, pl. 13, fig. 13; 1883, pp. 26–28, 66, 108, pl. 4, fig. 13.—Carus, 1885, p. 344.—Gourret, 1888, p. 1.—Koehler, 1890, pp. 137–138, fig. 11.—G. Sars, 1921, pp. 57–58, pl. 28, fig. 2.—van Oorde-de-Lint and Schuurmans Stekhoven, 1936, p. 121, fig. 75.—Lang, 1948, p. 3.—Sewell, 1949, pp. 170, 176, 177, 182, 188, 191.

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*Gunenotophorus globularis* Canu, 1891, p. 473; 1892, pp. 200–201, pl. 11, figs. 1–12.—Giesbrecht, 1892, p. 815.—T. Scott, 1900, pp. 387–388; 1901, p. 352; 1907, p. 366.—Brian, 1905, p. 3; 1906, p. 144.—Stebbing, 1910, p. 550.—Hartmeyer, 1911, pp. 1734–1735.—Schellenberg, 1922, pp. 258, 267–268, fig. 38.
*Gunenthophorus globularis* Graeffe, 1902, p. 40.
*Gunetotrophus globularis* Norman, 1905, p. 36.
*Guenenotophorus globularis* Harant, 1931, p. 371.
*Doropygus robustus* Pearse, 1952, pp. 189–191, figs. 2–8 (type locality, Alligator Harbor, Fla., in *Styela plicata* Lesueur).

DISTRIBUTION: Mediterranean to Norway and Sweden; British Isles; South Africa; Gulf of Mexico (Florida).

HOSTS: *Ascidia conchilega*, *A. prunum*, *Dendrodoa grossularia*, *Microcosmus microcosmus*, *M. sulcatus*, *Molgula ampulloides* (Bened.), *M. manhattensis*, *M. tuberifera*, *Pyura lurida* (?=*Cynthia lurida*), *P. mammillata*, *P. mentula*, *P. obliqua*, *P.* sp., *Polycarpa comata* Ald., *Polycarpa pomaria* Sav., *Styela coriacea*, *S. gyrosa*, *S. loveni* Sars, *S. rustica*, *Tethyum plicatum*, *S. plicata*.

SPECIMENS EXAMINED:

FLORIDA
From *S. plicata:*
Lemon Bay, Englewood, May 13, 1950, H. J. Humm, 48 females.

DESCRIPTION: Female (fig. 17,*a*): General features: The body (fig. 17,*a*) is 7-segmented, the greatest bulk being contributed by the much-inflated metasome, although the urosome is a markedly well-developed one. The head incorporates only the maxillipeds as a thoracic component. The lateral margins are produced as flaring epimera, which are directed somewhat ventrally. The segment of the first legs is free. The segments of the second to fourth swimming legs are tremendously inflated and incorporated in the ovoid brood sack which constitutes the bulk of the body.

The urosome is composed of four unequal segments, arranged as a gradually tapering cylinder. The first segment is the shortest and it bears the reproductive apertures. The second segment is as long as the succeeding two combined. The third segment is rectangular, about half again as long as wide. The terminal segment is of nearly the same proportions as the third but over-all is a slightly smaller somite. Articulated somewhat diagonally on the distal margin of the terminal segment are the laterally directed, somewhat dorsally curved caudal rami.

The front of the head is produced as a blunt, wedge-shaped rostrum with a very wide base.

Head appendages: The antennule is much inflated, particularly basally, so that it forms a short rounded cone. The segmentation is obscure but seemingly there are eight segments represented, these

FIGURE 17.—*Gunenotophorus globularis* Buchholz and *G. curvipes*, new species. *a*, *G. globularis* Buchholz, female, habit, lateral view. *b–r*, *G. curvipes*, female: *b*, habit, lateral view; *c*, urosome; *d*, terminal segment of urosome and caudal rami; *e*, antennule; *f*, antenna; *g*, masticatory lamella of mandible; *h*, palp of mandible; *i*, maxillule; *j*, maxilla; *k*, maxilliped; *l*, first leg; *m*, second leg; *n*, second endopodite; *o*, third leg; *p*, third endopodite; *q*, fourth leg; *r*, fourth endopodite. The scale, referring to *a*, represents 1.0 mm., that referring to *b*, 1.0 mm.

much telescoped apically. The taper of the appendage is pronounced, so that the very small terminal segment is subquadrate.

The antenna is stout, stumpy, and heavily sclerotized. The two basal segments are nearly equal in dimension except for the slight proximal flare of the basal segment related to the articulation with the head. The terminal segment is slightly over half as wide basally as the second segment and is inserted on the middle portion of the terminal margin of that segment. The distal segment is about twice as long as wide and tapers gradually to a blunt apex. Here is articulated a short, stout, curved, tapered hook. Accompanying the hook is one short setule. Inserted at about the midpoint of the outer margin of the segment is another reduced seta.

The mandible exhibits considerable modification of the rami. The protopodite is bimerous. The coxopodite is expanded medially as a masticatory lamella, the margin of which is sculptured into five widely spaced, subequal teeth, a finely serrated region, and two setiform processes. The basipodite bears a single stout seta inserted on the distal medial corner. The bimerous endopodite is considerably reduced. The basal segment is short, with its ornamentation consisting of a distally inserted medial seta. The terminal segment is about a fourth narrower than the first and about half again as long. It bears five subequal setae arranged rather regularly around the roughly rounded apex. The most lateral of the setae may be much reduced to a minute setule or fairly well developed.

The exopodite is large, fairly wide, and somewhat flattened. The sides are roughly parallel, although the entire structure curves somewhat, and the apex is broadly truncate. Two setae are inserted along the medial margin at regular intervals and three more form a fairly wide-spaced array around the apex. The most lateral seta is about half the dimensions of the next smallest.

The protopodite of the maxillule is so oriented that the line of demarcation between basipodite and coxopodite portions is diagonal. A medially expanded basal endite supports a row of masticatory setae of varied dimensions. A second endite is represented by a blunt base furnishing insertion for a fairly stout, tapering seta. The epipodite is represented by a short protuberance upon which is set a long, proximally directed seta accompanied by a reduced setule. The basipodite is so oriented that the exopodite is directed entirely laterally and the appendage is terminated distally by a quadrate process bearing four short, regularly spaced setae. Some of these represent the usual basipodite setae and some the setae of the completely coalesced endopodite. The exopodite supports four well-developed setae inserted along the distal margin.

The trimerous maxilla consists of nearly normally developed proximal segments with the articulations of the terminal portion completely suppressed. The basal segment bears three medial endites. The first endite bears three setae arranged in a somewhat transverse row. The second endite bears two equal setae. The third endite bears two subequal setae accompanied by a minute setule. The second segment is well developed and supports a very heavy, short, curved claw. Basally inserted on the claw is a seta accompanied by a reduced setule. The third segment is nearly obsolete, affording insertion for just two apical setae, the terminal one of which is reduced to a third or less of the dimensions of the more nearly normal proximal seta.

The segmentation of the maxilliped is obsolete and the appendage is flattened, with a roughly conical outline. The ornamentation consists of seven variously developed setae arranged as a transversely inserted trio at about the midpoint of the distal margin, a more distal transversely inserted pair of setae, and two nearly equal apical setae. The lateralmost setae of the two more proximal groups are much reduced.

Swimming legs: The protopodites of the first legs are bimerous and the rami are trimerous. A well-developed intercoxal plate yokes together the coxopodites. There is no medial coxal seta. Laterally inserted on the basipodite is a seta with the proximal half much expanded into a stout cylinder. At the medial distal corner of the basipodite is inserted a slender, tapered spine which reaches almost to the distal margin of the basal segment of the endopodite. The segments of the exopodite are subequal. The basal segment bears a large medial seta and, inserted on the distal part of the lateral margin, a much-reduced, short spine. The armature of the second segment is similar. The terminal segment is ovoid with the longer axis more or less transverse. Four long, well-developed setae are regularly inserted along the medial margin. On the apex and at the distal fourth of the lateral margin are inserted two short spines.

The endopodite is rather little modified. The segments diminish regularly in width distally. The two basal segments are of about equivalent subrectangular proportions but the basal segment is about twice as large as the second. Each of the two proximal segments bears a large medial seta. The distal segment is roughly a short, blunt cone bearing five setae: two are inserted on the medial margin; one is apical; one is just subapical laterally; and the fifth is inserted on the lateral margin one-third of the length of the segment distal from the articulation.

The articulation of the bimerous protopodite of the second legs with the body is diagonal, so that the lateral margin of the coxopodite

is double the inner. The basipodite is small and with the lateral margin so reduced as to make it almost triangular in outline. There is no ornamentation borne on the segments of the protopodite. The exopodite is massively enlarged to several times the bulk of the endopodite.

The proximal segment of the trimerous endopodite is a large unornamented rectangle. The second segment is of similar proportions but of about half the absolute size. The third segment is slightly longer than the second, slightly narrower, and forms a tapered cone with semicircular apex. Six or more reduced spinules are irregularly set around the distal margins of the segment.

The endopodite consists of a subquadrate basal segment, a second segment about twice as long as the first, and a third segment equaling in length the proximal two combined. Three successive flares of the margins of the terminal segment confer on it a characteristic outline. Reduced spinules are inserted on the apexes of the flares.

The third legs are nearly identical in configuration with the second, with minor differences in proportion and details. The segments of the exopodite are absolutely slightly longer. The endopodite is somewhat larger. The second segment here is three times as large as the first. The sculpturing of the margins of the terminal segments is considerably reduced.

The aspect of the fourth legs is still further modified. The armature of the terminal segment of the exopodite is reduced to just two or three minute spinules. The endopodite is more distinctive. The basal segment is still quadrate, but the terminal portion is a single unit representing the coalescence of segments two and three. This distal unit is nearly five times as long as the basal segment. It tapers slightly apically and the sculpturing of the segments of the anterior limb is here represented only by slight undulations of the margins. There are two minute apical spinules.

Vestigial legs and caudal rami: Fifth legs are lacking.

The caudal rami are short, stout, and slightly tapered. The length is about two and a half times the basal width. The armature consists of three short, stout spinules, and a stout setiform element all inserted in an apical row.

The male has never been described.

Remarks: This species has been thoroughly illustrated in the works of Canu (1892) and G. Sars (1921), and the American specimens conform well to these presentations, with some slight modifications, as specifically detailed above. The specific name of Claus has priority. Since it has never been applied to this species by any author since its original proposition, it is regarded as preferable to continue here the use of *G. globularis* Buchholz. This is in accordance with

the developing sentiment in favor of conservation of names of long standing which has been expressed in recent deliberations on zoological nomenclature.

***Gunenotophorus curvipes*, new species**

FIGURE 17,*b*,*r*

TYPES: Holotypic female, American Museum of Natural History Accession No. 6038 (type locality, Bering Strait, Alaska, in *Styela coriacea*). The other specimens examined are paratypes.

SPECIMENS EXAMINED:

ALASKA

From *S. coriacea:*

Bering Strait, July 1924, Capt. R. A. Bartlett, holotypic female.

From ?*S. coriacea:*

Exact locality unknown, 1930, 2 females.

DESCRIPTION: The outline of the body (fig. 17,*b*) approaches an uninterrupted ovoid, due to the marked inflation of the metasome and telescoping of the short segments of the urosome to reduce the obvious extent of the latter. The mass of the metasome represents the fused thoracic somites of the second to fourth legs, much inflated dorsally to form a brood cavity. The legs of each pair are well separated from each other by a wide midventral interruption, so that the appendages protrude laterally to give a mitelike appearance. The segment of the first legs is not obvious, and in the limited material available it has not been possible to determine if this somite is coalesced with the head or whether it is indistinguishably fused in the incubatory complex.

The urosome (fig. 17,*c*) is very short and stout. No segment is longer than wide and in the type specimen the segments are much telescoped. Similarly the terminal segment (fig. 17,*d*) envelops a considerable anterior portion of the caudal rami.

The rostrum is a well-developed anteroventral protuberance of the head.

Head appendages: The antennule (fig. 17,*e*) is modified, with segmentation suppressed and with a marked terminal taper. A considerable curvature obscures observation of the details, but it would seem that the appendage consists of four weakly setiferous, partially fused segments. The basal segment is large and seemingly unornamented. The second segment participates principally in the curvature. It bears a number of variously developed setae. The terminal segment probably involves fusion of two segments and it approaches the normal configuration found in other notodelphyids. It bears eight or more setae.

The trimerous antenna (fig. 17,*f*) is extremely stout, with a relatively weakly developed terminal segment. The basal segment is longest,

about half again as long as its greatest width. The second segment is massive, as wide as the first, somewhat wider than long, and with a relatively slight distal constriction. The distal segment is half as wide as the second and its length is roughly twice its width. Articulated terminally is a stout, tapered, markedly curved hook. Inserted at the base of the hook are two or three much-reduced setae. Another single seta is inserted a short distance proximal to this group.

The mandible consists of a bimerous protopodite and two rami. The coxopodite is extended medially as an unusually highly developed masticatory lamella (fig. 17,*g*). The serrations of the inner margin of the lamella are differentiated into several stout toothlike projections and a finely denticulate region. The basipodite (fig. 17,*h*) bears a single well-developed seta, inserted distally on the medial margin.

The endopodite is bimerous; the first segment is much smaller than the second. A single seta is inserted on the medial margin of the basal segment. The distal segment bears four setae, three distributed along the medial margin, one apical. The setae are subequal and the longest and stoutest of them are the two more apically placed.

The exopodite is much larger than the endopodite, stout, and somewhat tapered. Only traces of a fundamental segmentation are preserved. Four very stout, long setae are regularly spaced in a close-set row along the distal two-thirds of the medial margin. A much-reduced stub of a setule is inserted at the distolateral corner on the rather broadly truncate apex.

The maxillule (fig. 17,*i*) is characterized by suppression of the rami and distal portion of the protopodite and exaggeration in bulk of the proximal portion of the protopodite. The proximal endite is greatly produced medially and bears along the inner margin eight or nine closely set, stout, stiff masticatory setae. Inserted on the basal portion of this endite is a second process, bearing a single tapered setiform member. The remainder of the appendage is compressed to a palplike structure. Laterally at the base is borne a long, proximally directed seta representing the epipodite. Just distal to this a projection bearing four equal setae represents the exopodite in which the articulation with the segment has been considerably suppressed. An apical prominence bears three terminal setae and one medial seta. The anatomical explanation of this structure would assign the medial seta to the basipodite and the three terminal setae to the endopodite with the articulation again having been suppressed to near obsolescence, although faintly apparent.

The trimerous maxilla (fig. 17,*j*) is marked by great inflation proximally and some suppression of armature. The basal segment bears only three endites, the first one set with three setae, the next one set

with one seta, and the more distal one bearing two approximately equal setae.

The second segment is well developed and produced medially as a very stout, heavily sclerotized hook or claw. Basally inserted on the claw-process is one equally long, well-developed seta and a reduced setule. The reduced third segment bears three well-developed, subequal apical setae.

The maxilliped (fig. 17,*k*) is a reduced flattened plate with weakly sclerotized integument and suppressed segmentation. Five fairly stout setae are grouped along the medial margin. Two subequal setae are inserted apically.

Swimming legs: The first legs (fig. 17,*l*) consist of bimerous protopodites and trimerous rami. The coxopodites are yoked together by an intercoxal plate. Inserted on the medial distal corner of the coxopodite is a reduced seta which does not quite reach to the distal margin of the basipodite. Inserted at the lateral extent of the articulation of coxopodite and exopodite is a seta, of which the proximal half consists of a tremendously inflated base, and which is unusually long, extending to the proximal forth of the distal segment of the exopodite. A stout, tapered spine is articulated on the medial distal corner of the basipodite and extends well beyond the distal margin of the second segment of the endopodite.

The segments of the exopodite are much expanded and flattened, each somewhat constricted basally. Each of the two proximal segments bears laterally a short, stumpy spine. The armature of the distal segment consists of three similar spines regularly arranged around the broadly curving apex, and of four long, well-developed setae, disposed fairly evenly along the medial margin.

The basipodite is somewhat produced to articulate with the endopodite so that this ramus, although slightly shorter than the exopodite, actually extends a short distance beyond it. The two subequal basal segments bear each a long medial seta. The terminal segment bears three medial setae, two apical and subapical setae, and a lateral seta inserted in an emargination at about the midpoint of the segment.

In the second legs (fig. 17,*m*) the segmentation of the protopodites is obscured and the highly modified rami are trimerous. The protopodite is a massive protuberance upon which the rami are inserted. It lacks ornamentation. The mass of the exopodite is several times that of the endopodite. The articulations of the rami are such that they sprawl away from the central mass of the protopodite, the exopodite tending to take a lateral direction, the endopodite curling inward toward the midcentral line.

The two basal segments of the exopodite are roughly rectangular. The basal segment is about twice as long as wide. The second seg-

ment is more nearly subquadrate. Its width is two-thirds that of the basal segment. The length of the third segment is somewhat greater than that of the first segment and its width very little less than that of the second segment. The margins are parallel and the apex is a semicircle. A notable characteristic is the disposition of this segment in a 3-dimensional S-curve, the two loops of the curve arranged perpendicularly to each other. A few reduced spinules are inserted on the apical portion of the segment as the only ornamentation of the ramus.

The endopodite (fig. 17,*n*) consists of two small, rectangular proximal segments and a highly characteristic terminal segment. This segment is about three times as long as its basal width and features a series of elaborations of the integument. Each of these is a flare of the margin, terminating in a spinous projection and supporting a fringe of spinules. There are four of these, more or less alternated along the segment. A few spinules ornament the truncate apex. The segments are about equal in width except for the expansions of the terminal segment.

The third legs (fig. 17,*o*) conform very closely to the description of the second legs. The two distal segments of the endopodite (fig. 17,*p*) are proportionately somewhat longer than in the second legs.

The fourth legs (fig. 17,*q*) would also conform closely to the description of the second legs. The ornamentation of the exopodite is somewhat more profuse, consisting of six to eight small spinules. The endopodite (fig. 17,*r*) is slightly more distinctive. The two terminal segments are subequal and the elaboration of the distal segment is reduced. A spinule-like process is inserted subapically and the remainder of the ornamentation consists of a couple of spines and a row of fine spinules confined to the apex.

Vestigial legs and caudal rami: Fifth legs are lacking.

The caudal rami seem characteristically to be considerably enveloped anteriorly by the terminal segment of the abdomen. Each ramus is gradually tapered, its length about 2½ times its greatest width. The armature is obsolescent. The only element is a soft-textured, short, stout spine or seta inserted at the apex and seemingly retractile into a basal invagination.

No male has yet been found.

### *Scolecodes*, new genus

*Scolecimorpha* Henderson, 1931, p. 224 (part).

TYPE SPECIES: *Scolecimorpha huntsmani* Henderson, 1931.

At the time of the original description of the remarkable parasite more fully discussed below, it was assigned to the genus *Scolecimorpha* of G. Sars. Studies of additional specimens and reference to Sars'

description lead me to conclude the form is sufficiently distinct to warrant generic status. The absence of the labrum, a well-marked and highly characteristic feature of *Scolecimorpha*, the entirely different pattern of structure of the mouthparts, and the important feature in the body habitus of forming the brood sack to include one thoracic somite rather than four somites, seem justifiable grounds for this distinction. The original description by Henderson and the amplifications of detail provided below of the features of the single species will also provide the definition of the genus.

***Scolecodes huntsmani* (Henderson), new combination**

FIGURE 18

*Scolecimorpha huntsmani* Henderson, 1931, pp. 217–224, figs. 1, 2 (type locality, Departure Bay, British Columbia, Canada, in *Styela gibbsii* (Stimpson)).

SPECIMENS EXAMINED:

WASHINGTON

From *S. gibbsii:*

Off Upright Head, Lopez Island, dredged, Aug. 2, 1948, R. L. Fernald, 2 females.

Upright Channel, dredged in 25–35 fms., June 23, 1950, 17 females.

From *Pyura haustor* (Stimpson):

Indian Cove, Shaw Island, dredged, Aug. 18, 1948, R. L. Fernald, 3 females.

East of Upright Head, dredged in 25–35 fms., June 23, 1950, 80 females.

DESCRIPTION: Female (fig. 18,*a–g*): General features: The body (fig. 18,*a*) is an elongate, tapered cylinder with a more or less distinctively marked off head and thoracic region and a sharply articulated urosome. The cephalothoracic region shows no segmentation. A few minor indentations probably are vestiges of the original metamerism. The head region forms an anterior triangle. Behind it are the rather close-set four pairs of swimming legs. The portion of the thorax posterior to the swimming legs is about twice as long as the anterior sector. The incubatory cavity occupies all of the portion of the body posterior to the swimming legs as far as the urosomal articulation. A specimen in the adult stadium, but with undeveloped incubatorium, is illustrated (fig. 18,*b*), on the same scale as the above, for comparison. The urosome is a single segment bearing the caudal rami. The segment is about as wide as long, with markedly convex margins, the basal and apical widths being approximately equal. The range of size among the available specimens is 5.2 to 14.6 mm.

Head appendages: In the original description the mouthparts were not described. They are particularly difficult to observe since they are minute and are crowded into a depressed area of the ventral surface of the head. Furthermore, the lateral margins of the head are flattened and expanded into flaps which fold ventrally and tend to enclose the mouth region. In a favorable whole mount of the animal

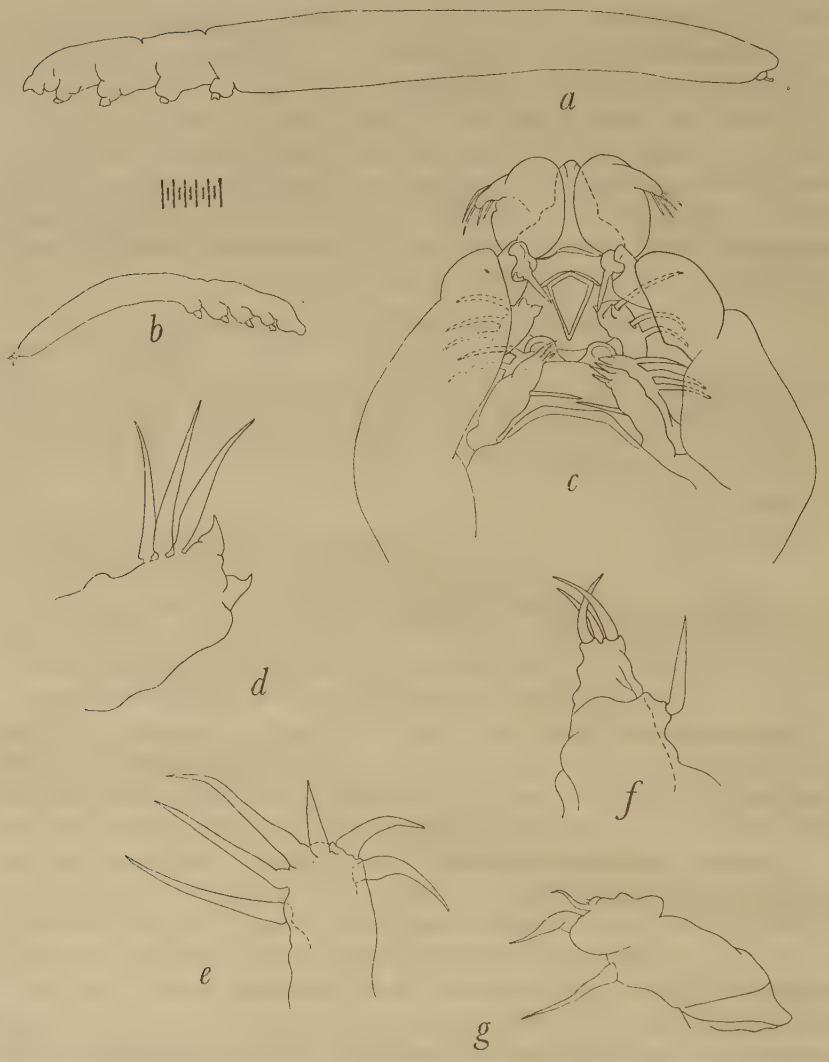


FIGURE 18.—*Scolecodes huntsmani* (Henderson), female: *a*, large ovigerous individual, habit; *b*, young adult female, nonovigerous; *c*, ventral view of head of female, illustrating the following head appendages, from anterior to posterior: antennules, antennae, first mouthparts, paragnaths, second mouthparts, third mouthparts; *d*, mouthpart of first pair; *e*, mouthpart of second pair; *f*, mouthpart of third pair; *g*, another view of mouthpart of third pair. The scale, referring to *a* and *b*, represents 1.0 mm.

it sometimes is possible to make out the mouth appendages (fig. 18,*c*). By tedious dissection most can be extricated for further detailed study.

The apex of the head is produced anteriorly and somewhat ventrally as an elongate, rather blunt rostrum with a wide base. The rostrum projects between the much-inflated bases of the antennules.

The antennule is bimerous. The basal segment is inflated to a nearly circular outline. The articulation of the second segment is not a sharp one. Apically is set a tuft of several setae.

The antenna might be considered as bimerous. The basal segment is considerably longer than wide. The distal unit consists preponderantly of the usual strongly prehensile hook, in this case with such a strongly expanded base as to suggest that this structure represents a reduced segment.

There is no conspicuously developed labrum or labium. The mouth opening is situated on a slight prominence and the mouthparts are arranged lateral and posterior to this.

The first pair of mouthparts (fig. 18,*d*) are roughly rectangular in outline. Two sharply acuminate, profusely ciliated prominences are set on the broadly truncate apex. Three long plumose setae are closely set distally on the lateral margin.

Posteriorly and medially to the bases of the first pair of mouthparts is set a pair of large paragnaths. These are long, inflated, and of roughly rectangular outline. The integument is so thin that all attempts to dissect them free from their site of insertion have failed. There is no armature (except for a fine ciliation) nor any indication of an articulation at the base.

The second pair of mouthparts (fig. 18,*e*) is very like the first pair. The outline is rectangular. At the center of the apex, on the distal medial corner, and far distally on the medial margin are set a close-spaced trio of markedly tapered, short, stout setae. These are profusely plumose. Equally heavily ciliated are three much longer setae inserted in a close-spaced row on the distal half of the lateral margin.

The complications of the integument of the third pair of mouthparts (fig. 18,*f*,*g*) suggest a partially suppressed bimerous condition. A long, stout plumose seta is inserted on the medial margin of the probable basal segment. On the truncated apex of the appendage are inserted three closely set, short setae.

Swimming legs: The four pairs of swimming legs are practically identical in construction. The protopodites are bimerous with a tendency to suppression of the segmentation, and the flattened rami are monomerous. The coxopodites are much inflated, knoblike protuberances. Reduced but distinctly observable intercoxal plates connect the members of each pair. The basipodite is of much smaller dimensions, furnishing little more than a common base for the insertion of the rami. There is no ornamentation of either segment of the protopodite.

The rami also are of practically identical construction throughout. The exopodite is a flattened ovoid plate with a widely transverse base and tapers to a rather narrow apex. The length is about half again

as great as the width. The whole external margin supports a compact row of short, stout spinules, usually eight or more in number. Apically and along the medial margin are set much larger, similarly proportioned spines, with bases adjacent, to the number of three to six.

Illustration and representative counts of the ornamentation of the limb series are presented in the original description of the species. These are representative as applying to the specific features of a given individual: First leg, exopodite, seven small lateral spines; three large terminal and medial spines; endopodite, eight small lateral spines, five large terminal and medial spines.

Second leg, exopodite, ten small lateral spines, six large apical and medial spines; endopodite, ten small lateral spines, six large apical and medial spines.

Third leg, exopodite, eleven small lateral spines, five large terminal and medial spines; endopodite, nine small lateral spines, six large terminal and medial spines.

Fourth leg, exopodite, eleven small lateral spines, four large terminal and medial spines; exopodite, ten small lateral spines, eight large terminal and medial spines. All the spines of this ramus show a tendency to form an irregularly double row.

Vestigial legs and caudal rami: Fifth legs are lacking.

The caudal rami are short, regular, markedly tapered, and terminally bear a row of four subequal setae. The length of the ramus is about 2½ times its basal width. The apical width is slightly more than half that at the base. The setae are about half again as long as the basal width.

No male has yet been found.

Remarks: The outstanding features of the biology of this copepod as it is so far known were discussed in the original description. All the specimens of the original lot were taken in association with *Styela gibbsii* (Stimpson). *Pyura haustor* (Stimpson), in the present findings, is recognized as an equally susceptible host. The association was noted in the first published notice of the species (Huntsman, 1912, p. 117) in which it simply was indicated as a parasite of the endostylar vessel in both known hosts. The tendency to multiple infection was noted by Henderson. In one specimen of *P. haustor* collected for the present study, 23 specimens of the copepod, of various sizes, were obtained from the endostylar vessel. No noticeable effect on the host of this massive invasion, other than the mere physical intrusion, was observed. The nauplius was described by Henderson. The smallest females taken are not ovigerous but they are identical anatomically with the largest.

The color of the examples here studied in life was a pale, semi-opaque yellowish flesh color, with some pale orange markings. The eggs were white.

### *Pholeterides*, new genus

The genus is monotypic, with *Pholeterides furtiva*, new species, described below, the type species. The specific description will also serve for the characterization of the genus, as it is so far known.

#### *Pholeterides furtiva*, new species

FIGURE 19

TYPES: Holotypic female, USNM 92809 (type locality, Washington Sound, Wash., in *Amaroucium californicum* Ritter and Forsyth), and paratypic females.

SPECIMENS EXAMINED:

WASHINGTON

From *A. californicum:*

West of Lopez Island, dredged, July 13, 1950, holotypic female and four female paratypes.

North of Upright Head, Lopez Island, dredged in 40 fms., Aug. 4, 1953, R. L. Fernald, 1 female.

DESCRIPTION: Female (fig. 19,*a–n*): General features: The body (fig. 19,*a*) is delimited sharply into a sausage-like metasome with segmentation obsolete and a markedly segmented urosome. The incubatorium occupies about half the mass of the metasome and extends from the level of the first swimming legs to the posterior margin of the tagma. There is no sign of segmentation of the metasome. The integument is thin and profusely haired. The head appendages are more or less vestigial and their placement is well anterior in the area corresponding to the mouth region. The first three pairs of swimming legs are fairly regularly spaced so that the third pair is inserted just slightly anterior to the midpoint of the metasome. The distance to the fourth pair of legs is somewhat more than double the interval between the preceding pairs. A fourth of the mass of the metasome extends posterior to the level of insertion of the fourth legs.

The urosome (fig. 19,*b*) is trimerous with apically inserted caudal rami of most distinctive aspect (fig. 19,*c*). The rami are mammiform, the length of each approximating about half the diameter of the expanded base. Each has a curved, acuminate apex, directed ventrally. The segment bearing the caudal rami is of about the same length but of slightly lesser diameter than the preceding segment. The first segment is twice as long as the combined second and third segments and slightly greater in diameter than the second somite.

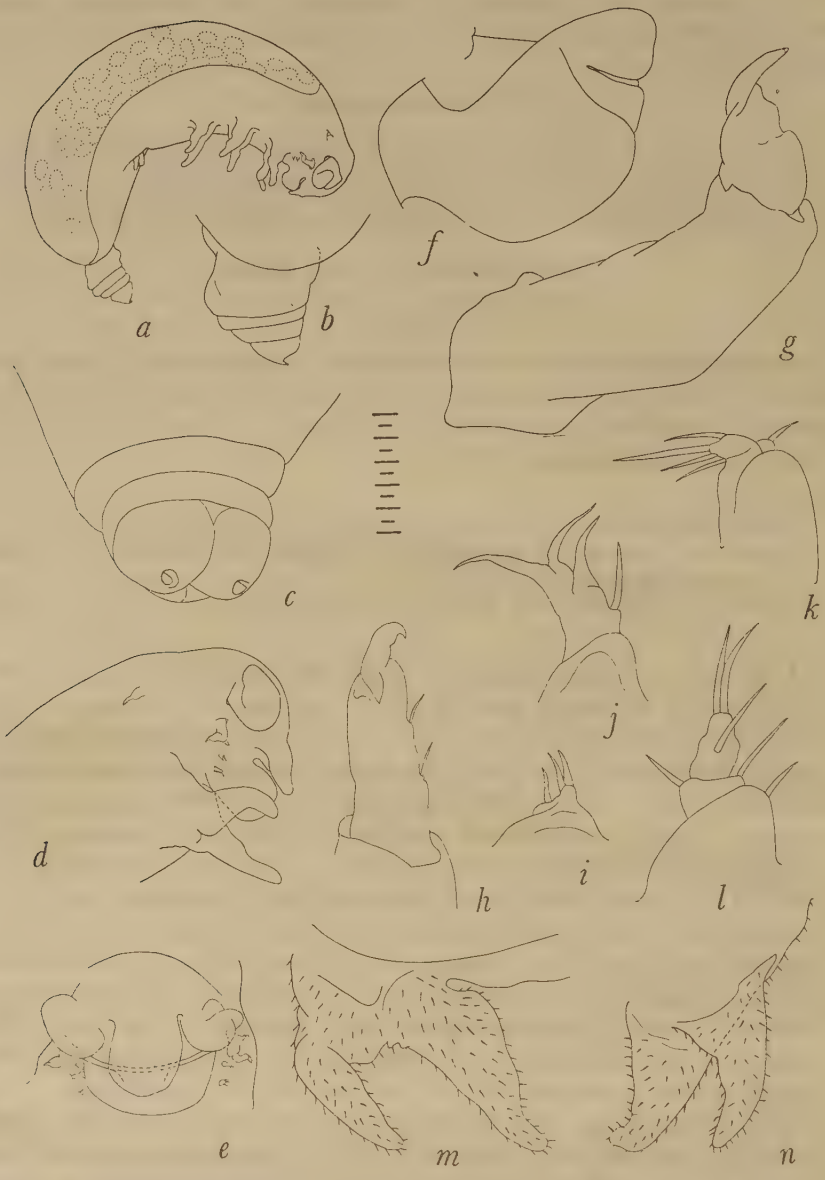


FIGURE 19.—*Pholeterides furtiva*, new species, female: *a*, habit, lateral view; *b*, urosome; *c*, caudal rami; *d*, head, lateral view; *e*, head, apical view; *f*, antennule; *g*, antenna; *h*, distal segment of antenna; *i*, mouthpart of first pair; *j*, mouthpart of second pair; *k*, mouthpart of third pair; *l*, another view of mouthpart of third pair; *m*, first leg; *n*, fourth leg. The scale, referring to *a*, represents 1.0 mm.

Head appendages: The most striking feature of the head is the complication of the oral region (fig. 19,*d*,*e*). I could find no mouth opening. At the expected level of the mouth an inflated cylinder curves transversely across the ventral side of the head. This structure must represent a much modified labrum or labium. Reaching posteriorly and ventrally to come in close approximation to this structure is the nearly equally inflated rostrum. All the head appendages are reduced and much displaced laterally, forming mere protruding lappets rather than elements of any obvious functional significance.

The antennules (fig. 19,*f*) are inserted laterally and curve outwards and upwards somewhat like ram horns. They are very wide at the base and taper rapidly to the curved apex. The segmentation is obsolete but indications seem to remain in sutures or sulci in the integument. There is no differentiated armature.

The bimerous antenna (fig. 19,*g*) preserves the greatest degree of indication of structural affinities with less aberrant notodelphyids. The proximal segment is long and slightly curved. It is unornamented. The length of the distal segment (fig. 19,*h*) is about twice its greatest width. It tapers to an articulation with a stout curved hook. Two reduced setae are inserted at about equal intervals on one of the margins.

The mouthparts are much reduced and anomalous. The presence of only three pairs, with no available distinguishing features, makes it impossible to homologize them with the usual notodelphyid appendages.

The most anterior pair of mouthparts (fig. 19,*i*) are reduced to small setiferous prominences situated far laterally on the head just caudal to the articulations of the antennae. Three close-set subequal setules constitute the armature.

The second pair of mouthparts (fig. 19,*j*) seem to be obscurely bimerous. The terminal portion bears four stout, much-tapered members of neither markedly spiniform nor setiform aspect.

The third pair of mouthparts (fig. 19,*k*,*l*) are the most complicated. They are seemingly trimerous, with enlarged basal portions. There is one seta inserted distally on the basal segment. The second segment is short and bears two setae, inserted oppositely on the segment. The terminal segment is about twice as long as wide and bears three setae.

Swimming legs: The segmentation of the biramous swimming legs is completely suppressed. The element on either side of any of the first three pairs (fig. 19,*m*) is a bilobed couple of elongate conical protuberances. They taper from a common base to narrowly rounded

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apexes. There is no armature. The fourth pair (fig. 19,*n*) is still more reduced in proportions than the preceding pairs but can only be characterized as shorter, somewhat thicker protuberances.

Fifth legs are lacking.

The male of the species is not known.

Remarks: Few details of the biology of this interesting species could be ascertained. The individuals all lie separately in small, cystlike cavities in the matrix of the ascidian, with no particular reference to the position of the tunicate zooids.

## Indeterminable Genera

### Genus *Salpicola* Richiardi

*Salpicola* Richiardi, 1880, p. 147 (type species, by monotypy, *Salpicola ialina* Richiardi, 1880).

#### *Salpicola ialina* Richiardi

*Salpicola ialina* Richiardi, 1880, p. 147 (type locality, Italian coast in *Salpa mucronata-democratica* Forsk).

*Salpicola hyalina* Carus, 1885, p. 43.

### Genus *Ophioseidus* Bate

*Ophioséide* Hesse, 1864, pp. 354, 358 (type species, by monotypy, *Ophioséide cardiocéphale* Hesse, p. 354 (nomen nudum)).—Marschall, 1873, p. 415.—Scudder, 1882, p. 221.—Schulze, Kükenthal, and Heider, 1933, p. 2361.—Neave, 1939, vol. 3, p. 437.

*Ophioseidus* Bate, 1864, p. 309.—Schulze, Kükenthal, and Heider, 1933, p. 2361.

*Ophioseides* Gerstaecker, 1870–1871, p. 719.—Wilson, 1932, pp. 600–601.

This genus is here restricted to the following indeterminable species.

#### *Ophioseidus cardiocephalus* Bate

*Ophioséide cardiocéphale* Hesse, 1864, pp. 354–356, pl. 12, figs. 33–42 (type locality, northern coast of France, in "Botrylle" (nomen nudum)).—Giard, 1873, pp. 498–499.

*Ophioseidus cardiocephalus* Bate, 1864, p. 309.

*Ophioseides cardiacephalus* Gerstaecker, 1870–1871, pp. 774, 801.

*Ophioseides cardiocephalus* Chatton, 1909a, pp. 11, 18–19.—Hartmeyer, 1911, p. 1734.

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